Engineering Record

A Weekly Journal Devoted to Civil Engineering and Contracting

PUBLISHED BY McGRAW PUBLISHING COMPANY, INC.

Volume 74 NEW YORK, SATURDAY, SEPTEMBER 23, 1916 Number 13

Quebec Span to Be Rebuilt

IT WILL BE a source of great satisfaction to all engineers to know that the St. Lawrence Bridge Company, contractor for the Quebec Bridge, has already taken steps toward the rebuilding of the suspended span, and to learn also its announced intention of hoisting the structure to place by the identical methods used last week. The Engineering Record predicted that such would be the case. The anchor and cantilever arms have been tried under a most severe load and have come through unscathed. The hoisting equipment was satisfactory in every respect. A single detail failed, and a repetition of that failure can be easily guarded against next year. No one who has studied the details of the hoisting plan, and has learned of its smooth operation until the moment of failure, will doubt that a year or so hence the suspended span will rise smoothly and safely and close the 640-ft. gap between the ends of the cantilever arms.

The Supermule

PROGRESS in the use of motor trucks has been so rapid that this journal has been prepared to believe almost anything regarding their wonderful powers. Years ago, when the use of motor trucks by contractors was in its infancy, the name of "mechanical mule" was borrowed from mining practice and applied to them. The term expressed the high regard in which the old-time contractor held the abused, but invaluable, four-footed feature of his "outfit." But the truck has proved to be more than a mechanical mule. It is a supermule. It has all of the virtues and few of the vices of its humble predecessor, and, in addition, qualities that are entirely different in nature and degree. Occasionally, but very seldom, it balks, probably to remind us of its predecessor and to school us to a proper humility. In hauling power and staying quality it leaves its erstwhile rival hopelessly outdistanced. With these thoughts in mind we were almost ready to believe this week's dispatches from Flanders. The cablegrams said that armored motor monsters had climbed a redoubt and killed men in it. "They cut up houses and put the refuse under their bellies and walk right over it. They knock down trees like match sticks. They go clean through a woods. They leap ditches like kangaroos. They simply love shell craters—laugh at them." With all our faith, we could not help but feel some doubt as to the truth of the statement. The correspondent had probably had the nightmare. We were worried, too, by having fun poked at the trucks. A day later the mystery was cleared up. It appears that these demons are none other than our well-known caterpillar tractors (American made), wearing steel clothing appropriate to the war zone. The explanation is satisfactory and has restored our poise. Our faith is even more firm than before—for is not the caterpillar tractor first cousin to the motor truck? And we have seen the caterpillar brave conditions that would appall other machines.

Co-operating with the Scientists

THIS WEEK a meeting was held in New York which may, and we sincerely trust will, mark an important step in the broadening of the co-operative activities of our national engineering societies. The meeting was that of a conference committee representing, on the one hand, the National Academy of Sciences and, on the other, the national chemical, civil engineering, mechanical, electrical and mining engineering bodies. The purpose of the committee, appointed in pursuance of a resolution of a preliminary meeting held last May, is to work out some plan by which the pure and applied sciences of this country can work together on matters of common, and of public, interest. The National Academy of Sciences is the leading body representing pure science in this country. It was chartered by Congress during the Civil War for the purpose of aligning the scientific skill of the country in support of the government during the war and during the peace that was to follow. As its title, "Academy," indicates, its scope, as to membership, is much more limited than that of the engineering and chemical bodies represented at the conference. The problem, therefore, apparently is not one merely of securing co-operation between the academy and the engineering societies, but rather of mobilizing pure science and engineering and chemistry for the public good. The Engineering Record trusts that the deliberations, under way at this writing, will result in the adoption of some working agreement by which these great forces can be brought effectively together.

No Water-Power Legislation

AGAIN a session of Congress has closed without giving to the industrial interests of the country legislation which would encourage them to develop the country's wasting water power. Year after year men who have understood the situation thoroughly have given generously of their time to advise senators and members of the House. Many who appeared at the hearings and advised with the committees, it is true, had an "axe to grind." They were prospective bidders for the powers that would be made available. Nevertheless, the money and time they have lost must eventually be charged up to the public, as is every economic waste. At the last session prospects for legislation seemed to be particularly favorable. Having inherited certain measures from the previous Congress—measures that had already gone through committee and been whipped into good shape—the session had an excellent start toward the enacting of effective and satisfactory laws. Preparedness and appropriations, however, had the right of way, and tremendous water powers must still continue to waste for lack of proper statutory provision. More interest was displayed in the measures recently, however, than ever before, justifying the hope that the needed legislation may be secured soon.

Standardized Water Meters

WHAT success will attend the plan for standard specifications for water meters, proposed at the convention of the New England Waterworks Association in Portland, Me., last week by Robert J. Thomas, only the future will disclose. If a superintendent of a municipal waterworks plant could go into the open market and purchase the meter which his experience indicates to be the best, the need for a standardized specification would not be felt. Under present conditions, however, ordinances in many localities require the award of a contract to the lowest responsible bidder. Under such conditions specifications are necessary, but Mr. Thomas finds that those now in use contain merely a few broad requirements which all meters can fulfill. Specification requirements regarding accuracy or sensitiveness, test pressure, loss of head, testing rates, maintenance of accuracy and similar important matters are conspicuous by their absence. From his survey of the field Mr. Thomas is led to the belief that the New England Waterworks Association has an opportunity for service in the field of meter specifications. Whether manufacturers of water meters will concur in this belief is open to grave doubt. The leading firms have been in the business many years and have developed designs which certainly could not be changed at short notice without a substantial loss in profit. The commercial side of this question is one which will have a decided bearing upon the ultimate results. The New England Waterworks Association has not taken any definite action upon Mr. Thomas' suggestion. It has, however, been authorized to appoint a committee to report on the possibility of standardizing water-meter specifications. It is impossible, now, to say just how far this standardization will go. The first step, if any step is taken, will probably be in the direction of standard requirements for accuracy and for methods of testing.

Limitations of Engineering as an Exact Science

IT IS NOT EASY, in the nature of things, for a layman, however intelligent, to gain a measurably correct conception of the difficulties that confront the engineer in the solution of his manifold problems. Engineering activities are apparently conducted with such unerring certainty, in the eyes of the casual observer, that he is unconsciously led to look upon engineering as an exact science. He utterly fails to realize that operations which seem to proceed with almost automatic ease and smoothness are in reality subject to innumerable contingencies which, if not adequately gaged in advance, would invite partial or complete failure.

The significance of full success under difficult circumstances for which there may be little or no precedent, and in which the failure of any one of numberless details may entail disaster to the whole, can be appreciated only by the trained engineer. He knows, too, how hazardous it is to lean too heavily upon theory alone in dealing—as he must at every turn—with the uncertain forces of nature and materials, concerning which human knowledge can be approximate at best. It is because these factors are inseparable from engineering enterprises that engineering—unlike its handmaids, mathematics and mechanics—can never become an exact science. That fact, however, serves as a stimulus rather than a drawback to engineering, constituting as it does, in the views of its followers, at once the hazard, the fascination and the glory of their profession. Engineers cannot be book-made. The highest professional achievements in engineering must be predicated on that happy blend of theory, practice and native common sense known as engineering judgment. That quality is, indeed, indispensable in the solution of difficult engineering problems. Such problems require the judicious integration of numerous factors which, though rarely susceptive of exact evaluation, have nevertheless to be recognized and given due weight at their approximately true values.

Thanks to modern engineering skill and foresight, great achievements in that field have become seemingly so commonplace and important failures relatively so rare, that in the superficial public view engineering has quite naturally come to be regarded as something at least closely akin to an exact science. The prevalence of that fallacy denotes, in its underlying basis, a high tribute to the profession. When failure does occur, however, as occasionally it must, that fallacy serves also to suggest the conclusion, in lay circles and in the public press, that it must have been due to incompetence, negligence, or professional culpability of some sort. It is, of course, not to be denied that in some, and perhaps most, instances such inferences are well founded. No one knows better than engineers, however, that in certain circumstances failures may occur for which no blame whatever can rightly attach to the engineers in charge. Whether the recent calamitous failure of the new Quebec Bridge presents such an instance can be established only by rigid inquiry. Pending this inquiry, the engineering profession can only hope that the preliminary evidence which points so strongly in that direction will be abundantly sustained. The previous records of the engineers concerned and their performances in connection with the design, fabrication and erection of this remarkable bridge have been so truly notable that their complete exoneration from any suspicion of professional dereliction would be hailed with profound satisfaction by their professional brethren.

What Caused the Initial Failure at Quebec?

CIRCUMSTANTIAL evidence presented at length in this issue seems to fasten responsibility for the loss of the suspended span of the Quebec Bridge on one of the castings of the rocker-joint bearing of the southwest lifting girder. This being conceded, the question immediately rises, What caused the initial failure? The detailed dimensions of the castings of the rocker joint are shown on page 370 of this issue. Data are not at hand as yet as to the composition of the metal; the results of breaking tests of bars from the same heat as the castings; the evidence afforded by microscopical photographs, if any; and the heat treatment to which the castings were subjected—all matters that will throw light upon their strength and reliability. A defect in one of the castings is, of course, one of the most obvious explanations.

Of the three castings, the two upper ones have disappeared, and of these the intermediate member, rather than the upper one, is open to suspicion. An examination of the design suggests at once the possibility of a large tensile stress due to bending of the projection. The wing resting upon the longitudinal pin, parallel to the main trusses, would be subject not alone to bending due to assumed uniform distribution of loading on the pin, but to added bending due to friction on the transverse pin, which would be induced by the deflection of the span and by the elevation of the south end 2 ft. higher than the north, which occurred during the lifting operation.

Furthermore, it will be noted that the parallel transverse pins through the diaphragms in the supporting girders (see sketch in last week's issue, page 366) and the transverse pin of the rocker-joint bearing, supporting the trusses, place the support in unstable equilibrium, except for the stiffness of the bolted connection between the stub link and the supporting girder. This connection is composed of a plate on each side of the stub link and connecting angles. While they appear to be sufficient to prevent any movement, the inquiry naturally comes as to the reason for using a pin for this connection. Any displacement of the upper pin with respect to the lower, resisted entirely by the friction on the pins and the connection just mentioned, would at once induce a twisting moment and a tipping of the girder. Had such movement occurred—and the photographs of the girders at hand do not show any distress in the connection between the stub link and the supporting girders—the casting would undoubtedly have failed to resist such overloads. The resulting diagonal motion of the supporting stirrup would follow very probably in exactly the manner indicated by the circumstantial evidence cited elsewhere.

As was said in this journal last week, now that the accident has occurred, it is easy to suggest some other detail for this important support. While the stirrup was for temporary use only, the manner in which it was required to lift, as on knife edges, a total load of 5100 tons subject to lateral and longitudinal forces surely calls for the use of the most reliable known material, high factors of safety and every precaution to insure stable equilibrium. Cast steel, while reliable in compression, is unreliable in bending, especially for such thick castings as were here required, for which the heat treatment is such a vital factor.

Further study of the details of this casting—so far as their composition and manufacture are concerned—is necessary before the engineering public will be fully satisfied that it has learned all possible lessons from last week's disaster.

Prosperity Follows Western Highway Construction

TOURIST travel in the Western States by automobile has reached almost unbelievable proportions. Even in such out-of-the-way sections as Western Colorado the hotels are crowded to overflowing by the motorists. The highway officials of Colorado estimate that the 100,000 visitors this year left $9,000,000 behind them. This is based on an expenditure of $3 per day by each person for the average period of thirty days during which each of the 25,000 cars was in the State. As a result of the traffic—and the gold it leaves behind and may bring in future seasons—all the wayside inns and the abandoned mining towns of former boom days are clamoring for good roads into their sections. It is indeed a diplomatic engineer who can keep harmonious relations among all the advocates of rival roads when a tempting slice of the $9,000,000 State-aid fund is in sight.

The situation occasionally has an angle of importance to railroads little appreciated. The southwestern section of Colorado, with its historic cliff dwellings, has recently been made accessible, at a comparatively small expenditure, by a pass road over the Continental Divide, as described on page 378. The section is rich, also, in minerals and lumber and has a large grazing acreage. To get to it by rail from Denver or Colorado Springs formerly required a trip into New Mexico and six hours more in time than is now required by automobile. The possibilities are inviting for the establishment of an auto stage. Already the railroad has lost as passengers many commercial travelers; they now travel in motor cars and carry their stocks and samples with them. Cattle and sheep can easily be driven to a station on the other side of the range, saving the ranch owner $26 per car in transportation, in addition to giving him access to government range for fattening his stock. The prospective competition, due to the expenditure of a sum which will hardly build a mile of heavy railroad construction, is sufficiently strong to have made the railroad survey a new line paralleling, in part, the highway.

Similar topographic conditions, unfavorable to railroads, but not forbidding to highways on which motor trucks and automobiles can operate with economy, are to be found in many sections of the country.

Lost—20 Per Cent of City Water Supplies

CAN the present condition of pipe lines, so far as leakage of joints is concerned, be considered satisfactory? This, in effect, is the question raised by Frank A. Barbour, chairman of the committee on pipe joint leakage, in his statement (see page 385) at the annual convention of the New England Waterworks Association in Portland, Me., last week. The apparent apathy of the association's membership, which was the reward of his effort to analyze the problem and reach conclusions of value—only one in five of the members replying to the questionnaire issued by the committee—would lead to the inference that the subject was not considered of particular importance. Yet this assumption is obviously wrong, for Mr. Barbour's figures show that even under the best possible conditions—in fully metered cities—20 per cent of the total water supply is, as a rule, unaccounted for.

What becomes of this waste? It must be charged either to faulty meter registration or to leakage from pipe joints in mains or service connections. Reduced to a basis of dollars and cents Mr. Barbour's findings demonstrate that a town of only 10,000 people would be justified in spending $20,000 to prevent a water loss of only 14 gal. per capita per day. These figures present the case in a decidedly interesting light. Yet, in spite of them, water departments appear to be entirely in the dark when it comes to their ability to make even an approximate estimate of losses from leakage. Ninety-nine of the 131 departments sending in replies make no attempt to state this loss in definite terms. Ostrich-like, they bury their heads in the sands of conjecture when trouble threatens. Strategy of this sort will not help much in the fight to reduce water leakage. Before conditions can be improved complete and reliable information regarding present practice must be presented. Then remedial measures may be intelligently planned.

As the initial step in the work, the chairman of the committee on pipe joint leakage sent a list of 37 questions to 430 members of the New England and to 124 members of the American Waterworks Association. From the 554 circulars sent out 131 replies were received, 46 of these being from American and only 85 from New England members. This discouraging response led Mr. Barbour to remark: "It may be that leakage from pipe joints is not generally an important factor and that the present type of joint, driven and tested, or not tested, as may be the practice, is entirely satisfactory." Possibly the subtle sarcasm of this statement did not exert its full force upon the members at the Portland meeting. Mr. Barbour might have fared better if he had discarded the rapier in favor of the bludgeon—if he had said, for instance, that the traditional excellence of the committee work upon which the New England Association prides itself would be a thing of the past if such lack of co-operation by the members in the work of one of its own committees were permitted to become general.

A task such as the one devolving upon the chairman of the committee on pipe joint leakage is not a one-man job. The success of all work of this kind depends upon the full co-operation of the association's membership in supplying the information needed by the committee. The members must realize that the chairman of such an investigating body is called upon for an enormous volume of gratuitous work. In fact, his sacrifice is measured not merely by his own time but often by a very substantial expense account paid out of his own pocket. It is clearly unjust to expect a man to make this personal sacrifice without affording him, at the same time, the solid backing of the association's members who are in a position to supply the data needed in the committee's work.

From the committee's preliminary report it is clear that the evidence already collected does not justify a conclusion as to whether or not it is economically possible to reduce pipe-joint leakage by a better type of joint, better workmanship, or testing at pressures above normal. To these questions definite answers should be made. The information most needed to reach a conclusion is that giving the results of leakage surveys, of actual tests made after the pipes have been in service some years, of experimental work showing the relation between pressure on the joint and leakage and, particularly, data from those departments where accurate tests have shown leakage in mains to exist.

The Man from Home—Again

IT IS NOT UNCOMMON to hear complaints when engineers are called in from a distance to study local problems. Generally the dissatisfaction exhausts itself in a few vocal protests, and the onlookers quote the adage, "A prophet is not without honor," etc., or attribute the complaints to the narrowness of the protestors.

Canadian engineers are now objecting to the employment of a distinguished American to take charge of the valuation of the railways of Canada. "Canada for the Canadians," is their principle, especially, they declare, when there are Canadians capable of supervising the work. The protest, were it individual, might be overlooked. It is made, however, by the council of the Canadian Society of Civil Engineers. Whether the circular sent out by the council, and reprinted on page 380 of this issue, represents the views of the majority of the society's members this journal does not know. It would be interesting, indeed, to find out.

It cannot be denied that the protest is natural. National pride is a sufficient explanation — particularly at this juncture when all elements in Canada are pulling together as never before to do their "bit" to support the empire in its great conflict.

Moreover, "people who live in glass houses" should be careful of their criticisms. In most of our states the civil service laws bar residents of other commonwealths from examinations. Even cities have a residence requirement which disbars the non-resident from competing. True, in most cases the residence rule is waived in examinations for technical positions. Even the United States government takes a narrow view of the matter of employment; save for technical positions, appointments are made on the basis of apportionment to the various states. Only recently (in the issue of Aug. 19, 1916, page 218) the Engineering Record in an editorial entitled "The Man From Home" had to disagree with one of its correspondents who objected to the employment of non-resident consulting engineers.

That we, too, as a people, consider employment as a local matter does not, of course, justify either our position or that of the Canadian society. We can understand the reason for the latter body's position. But as we wish that our own people may take a broader point of view, so do we hope that our Canadian brethren will change their attitude. We can readily conceive that there might be justification for protest in individual cases, but to erect sectional or international lines and characterize their maintenance as a principle is, in the judgment of this journal, an indication of a narrowness that is not in keeping with the dignity of a professional body.

Even though there may be sympathy on this side of the border with the Canadian body's position in general, in the particular case in question the society finds itself in a most unenviable position. The American engineer whose appointment has brought about the present protest happens to be a member of the Canadian society. He has been welcomed into the fraternity of Canadian engineers, though that fraternity wishes now to deny him the right to practise in Canada, at least when government service is in question.

What, then, does society membership mean? Is it an empty thing to be appraised by the way the wind may be blowing at the time? Is an engineer to be welcomed at the front door and have hands raised against him after he is in?

The Canadian society will have little trouble—on the broad ground of keeping its engineering appointments at home—in justifying its position to many American engineers. Even among those who deplore the protest and the stand taken there will be a sympathetic understanding of the reason for the action. There will be few, though, who will believe that the society can square its admission of an alien engineer to membership with its effort to prevent him from practising his profession, even if the limitation is to apply only to Canadian government work.

Breakage of Casting of Rocker-Joint Bearing Responsible for Quebec Bridge Disaster

Evidence of Damage on Lifting Girders Points in That Direction—Span Did Not Slip from Hanger—Condition of Girder at Southwest Corner Tells Graphic Story

THE EXPLANATION offered in the Engineering Record last week as to which detail failed at the Quebec Bridge and precipitated the suspended span into the river on Sept. 11 has been corroborated by the evidence afforded by a further inspection of the lifting girders. In fact, it is reasonable to say that all theory must now be dismissed. The circumstantial evidence is conclusive.

To understand fully what occurred the reader needs to comprehend clearly the detail of the rocker-joint bearing between the lifting girder and the suspended span. Reference is made to the accompanying drawings, Figs. 1 and 2, and to the photograph, Fig. 3. The main features of the bearings are three steel castings and two forged pins. The latter are at right angles to each other and, with the castings, form a universal joint. It should be understood that the bearing as shown in the photograph, Fig. 3, does not represent the detail as it was when the span was being hoisted. Previous to floating and after this photograph was taken, two hitch connections, indicated in Fig. 1, were added. These hitch connections carried the lifting girder when the span was being floated up the river. Then when the span was on the barges, centering plates, shown in the lower right-hand sketch of Fig. 2, were added. These plates insured the absolute centering of the lifting girder on the bearing when the load of the span was transferred to the hoisting chains. These plates were shop-fitted and bore against a chipped surface on the arm *C* of the intermediate casting (Fig. 3). A black streak at *D* shows plainly where the chipping was done in one of the angles of the casting. The plates and castings were match-marked. It was therefore impossible to put them in place until the girders were accurately centered on the intermediate casting. Once in place they prevented movement in a direction parallel with the length of the span. Their use permits one to dismiss immediately any theory that the load was placed eccentrically on the girder and caused it to cant.

What the Lifting Girders Show

As recited in this journal last week, and as shown by the photograph of the falling span there published, the southwest corner was the point of initial failure. The hanger at this point will therefore be first studied. The condition after the span had fallen is shown in Fig. 4. The picture was taken looking in a southwesterly direction. In other words, the face of the girder shown is toward the channel, while the hanger is the westerly, or upstream, one of the pair. It will be noted that the centering plate that had been bolted on at *M* has been sheared off. The plate attached at *N* is ripped loose and lies twisted in front of its former position. The plate that was at *O* has disappeared, while the remaining plate *P* lies crushed against the pin, with the hitch connection of that side lying over it. The pin is scored in a diagonal direction, and has been rotated through a circumferential distance of 1½ in. toward the reader.

It is certain from this photograph that the span did not "slip" off the pin. If it had, the plate *P* would have disappeared, the scoring of the pin would not have been diagonal, the pin would not have been rotated, and the damage to the angles at *Q* would not have occurred. In no way, except by the falling of the span through the breakage of one of the castings or of a pin above, could the damage shown have been wrought. The failure of a pin is unlikely. Something broke and precipitated the span outward toward the river and toward the longitudinal axis of the structure. The angle of movement was about 30 deg. with the bridge axis, as is indicated by the break at *Q*, the scoring of the pins and the position of the hitch connection resting on the plate *P*.

The conditions at this corner, therefore, corroborate the explanation offered by this journal last week, save that an erroneous impression may have been conveyed by the use of the word "slip." The span moved not longitudinally over the long pin but in a diagonal direction. This could only have occurred if something above broke. The breaking of a main truss member—which has been dismissed by every engineer for obvious reasons, as well as on the basis of the evidence afforded by the photograph and by those who saw the span fall—would

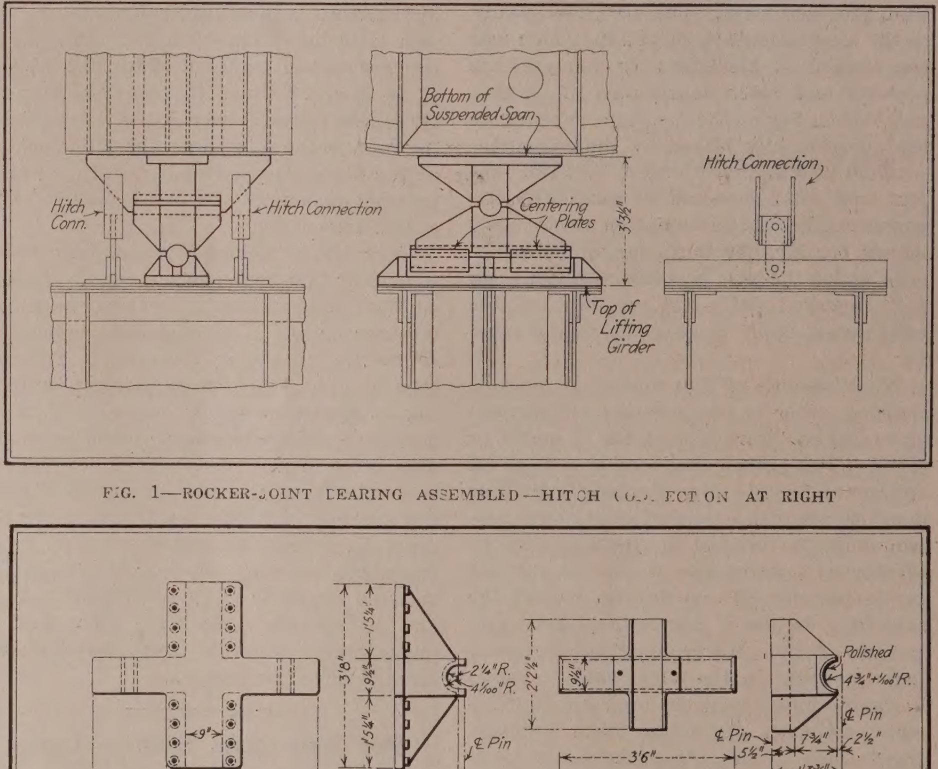


FIG. 1—ROCKER-JOINT BEARING ASSEMBLED—HITCH CONNECTION AT RIGHT

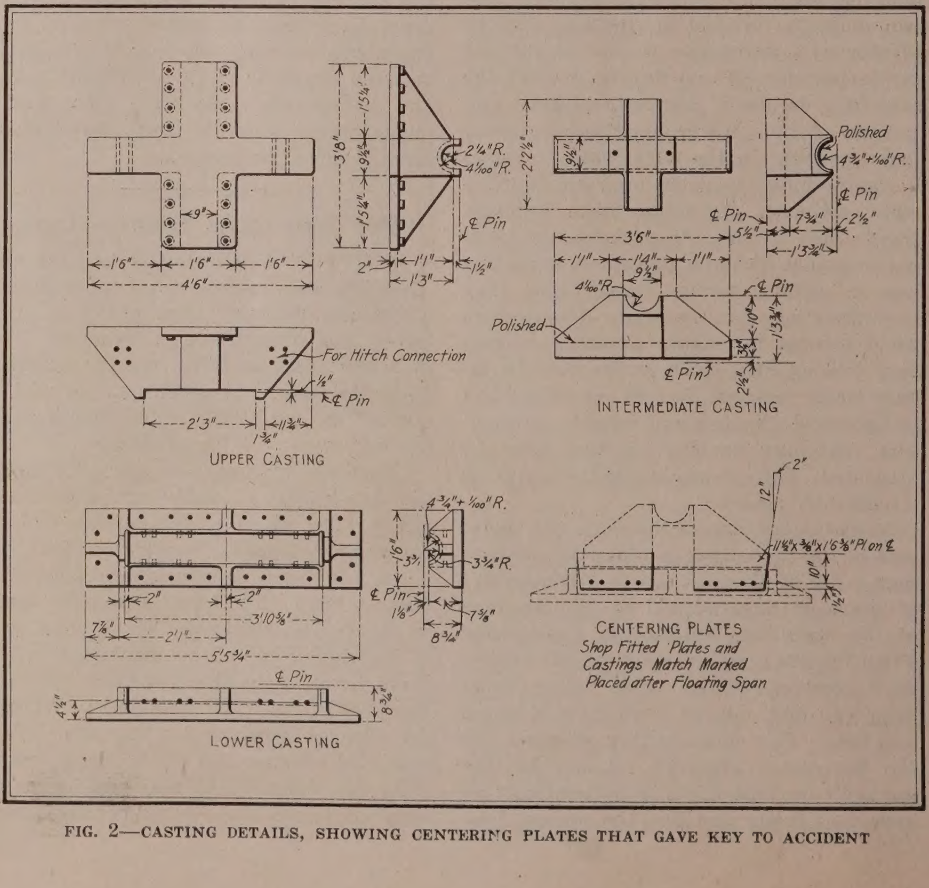


FIG. 2—CASTING DETAILS, SHOWING CENTERING PLATES THAT GAVE KEY TO ACCIDENT

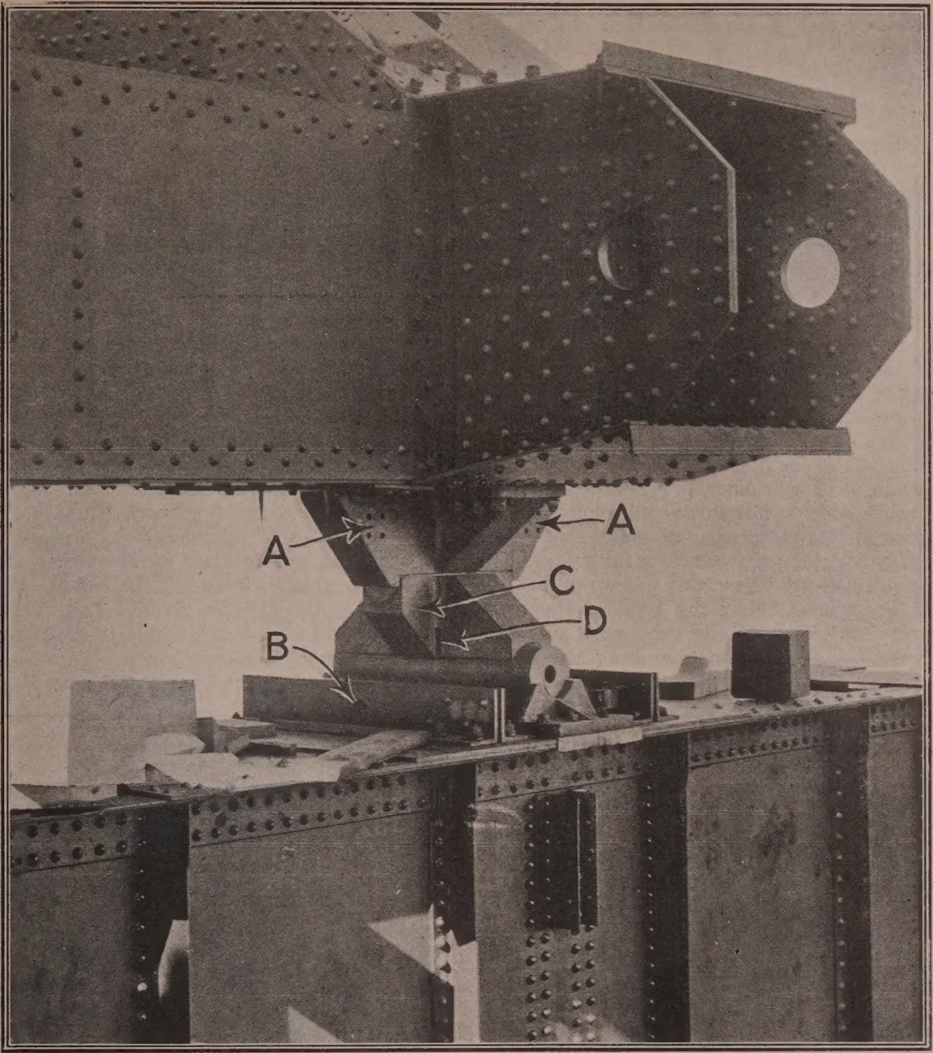


FIG. 3. ABOVE—ROCKER-JOINT BEARING CARRIED SPAN LOAD TO LIFTING GIRDER

have probably carried the end off in a direction parallel with the pin. A study of the other three lifting girders also tends to corroborate the conclusion drawn from the southwest girder.

The southeast lifting girder is shown in Fig. 5. The view is taken from the channel side looking eastward, or downstream. It will be noted that the centering plates are, all four, still bolted to the lower castings. All of them are flared outward, while the one nearest the reader in the view has been battered down in the crash. The pin shown is not, as was reported in this journal last week, the broken half of the longitudinal pin of this bearing but the shorter transverse pin which carried the load from the upper to the intermediate casting.

It is apparent from this view that the falling of the southwest corner twisted the southeast corner of the span in a counter-clockwise direction (looking at it in plan) and at the same time carried it in a clockwise direction, considered in a vertical plane parallel with the lifting girder. The counter-clockwise movement accounts for the flaring of the plates. This movement also explains how the transverse pin came to fall into the longitudinal bearing, after the longer pin had disappeared.

The crushing of the angles on the side toward the inside of the span indicates that this corner, too, went off in a diagonal direction—toward the center and the inside of the span.

Fig. 6 is a view looking downward upon the lifting girder at the southeast corner—the one shown in the larger photograph, Fig. 5. This view is reproduced in order to show the kink in the stub end connecting the lifting girder with the hoisting chain. This hanger had to tear through a strut at the end of the span.

It should be noted here that this same kinking is found at the bottom of the inside hanger on each lifting girder. In every case the inside chain had to tear through the strut referred to. The distortion is greatest, however, in the case of the southeast girder, pictured here.

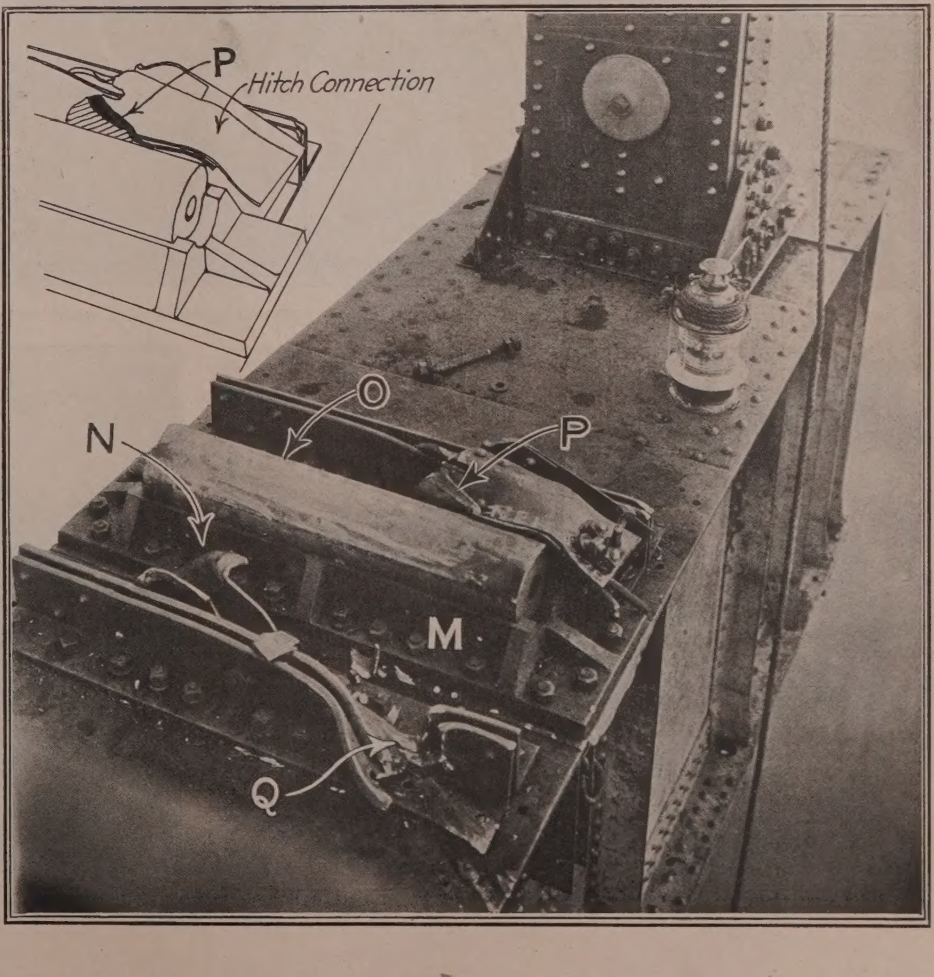
Fig. 7 shows the girder at the northwest corner, and Fig. 8 the girder at the northeast corner. Both views are taken from the channel side. It is apparent from an examination of them that the span pulled off in a direction parallel with the longitudinal axis of the span. The rear centering plates in each case stand untouched. The forward ones have been ripped from place. In Fig. 7 the forward one on the far side appears still to be standing and merely to be flared backward. As a matter of fact, it was torn loose and lying down, but was blocked up (as shown) after the accident and before this photograph was taken.

Further examination of the structure and of every feature of the hoisting equipment carries out the remaining statements made in this journal last week.

The number of lifts taken with the jacks was erroneously reported in this journal last week. Five lifts were taken at the north end and six at the south end.

(Figs. 5 to 8 appear on page 372)

FIG. 4. BELOW—INITIAL BREAK OCCURRED IN CASTING AT S. W. CORNER HERE SHOWN



Revolutionary Methods Used to Float and Hoist Center Span of Quebec Bridge

Six Barges Carry Span from Erection Site to Bridge, Where Suspender Links at Each Corner and Heavy Jacking Equipment Raise It Clear

ORIGINAL and, but for a sheer accident, entirely successful was the method devised for completing, by hoisting its central span 145 ft. from six barges on the river, the record cantilever bridge across the St. Lawrence at Quebec. The smoothness and precision with which the operations moved according to program up to the moment of the fatal accident excited the admiration of the foremost erection engineers of this continent, most of whom were present to witness the work.

RAPID ERECTION OF SUSPENDED SPAN

During the season of 1915 the north cantilever and the south anchor arms of the bridge had been erected, and the north traveler, its work at the site finished, had been taken down to be sent to Sillery Cove, 3½ miles below the bridge, for erecting the suspended span. This work was finished during the past summer while the south cantilever arm was being completed.

At Sillery, on a nearly level rock ledge bare at low tide and covered to a depth of 13 ft. at high tide, foundations for erection falsework for the suspended span had been prepared during 1915. The first work of the present season at this site, the building of a deck-girder trestle some 400 ft. long from the railroad tracks connecting with the bridge site to the point at the west end of the span where the traveler was erected, was begun with a locomotive crane on April 16. Before Aug. 1, not three and a half months later, the 5100-ton span of nickel steel stood ready for the removal of the falsework. The traveler as used here was put up minus one of the panels below the level of the boom seats and without the top panel and gantries, the four booms handling the entire work. Falsework, floorbeams and main posts were erected from west to east, using for the third time the interior falsework which had supported each anchor arm in turn. This falsework, planned for the purpose, also supplied girders for the traveler tracks, bearing on the floorbeams of the span. These girders, after serving three, and in some cases four, times, are still in perfect condition for use as standard bridge girders, for which they were designed.

Returning from east to west the traveler completed the center span, the inclined top-cord members in the next to the west panel being the last erected. Except for the center panels, where they supported the "quarter deck" from which the handling and placing of the span were directed, and the end panels, where they carried two hoists, the permanent track girders were left out till after the span was in place. Steel was delivered by rail during this operation. When it was complete the falsework beneath the span was released by sand jacks under the panel points, and most of it removed by the locomotive crane. This left the 640-ft. span resting on the lifting girders and rocker bearings at each corner, which in turn bore on four heavy falsework bents.

Meanwhile there had been built near Mon-

Stirrups at Corners of Suspended Span After Failure—*Photographs Illustrate the Preceding Article*

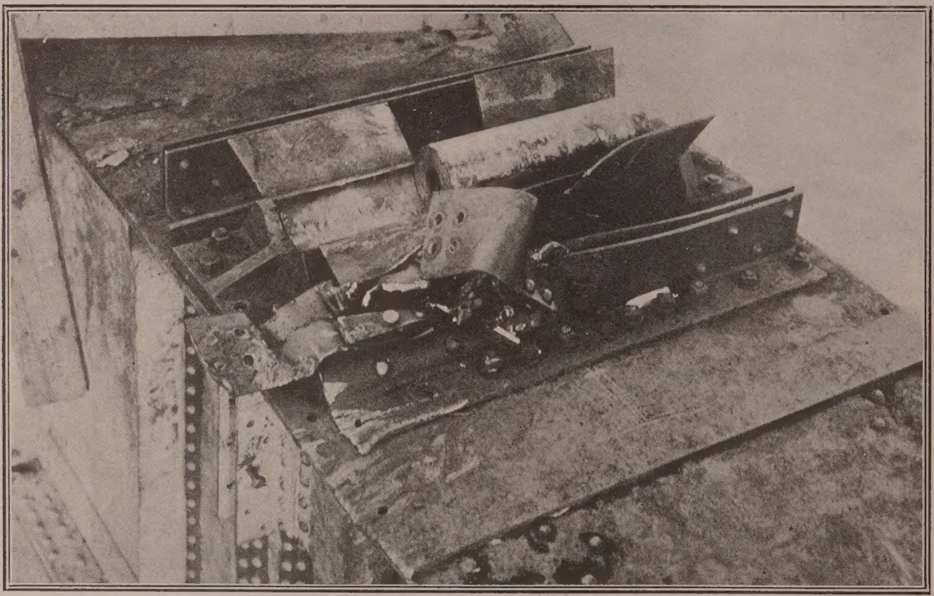


FIG. 5—FLARED PLATES, S. E. CORNER, SHOW INTERMEDIATE CASTING ROTATED IN GOING OFF

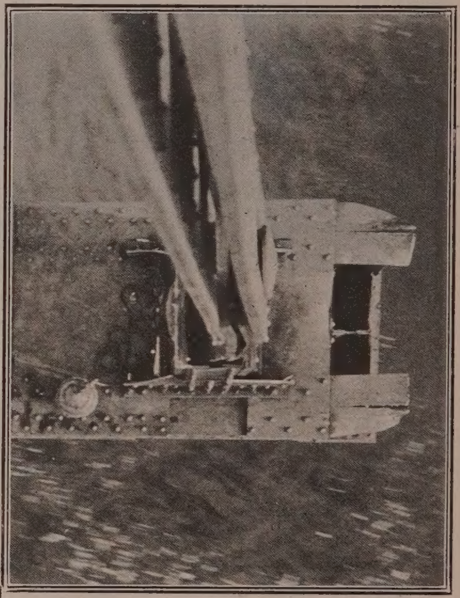
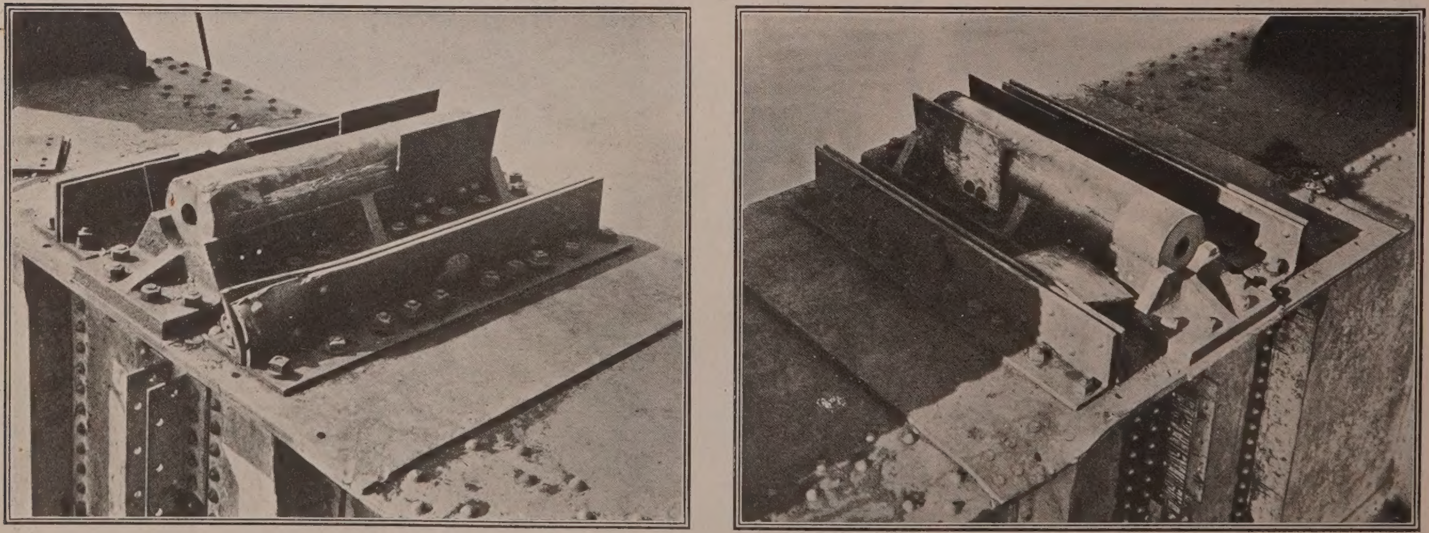


FIG. 6—BENT INSIDE LINK, S. E. STIRRUP

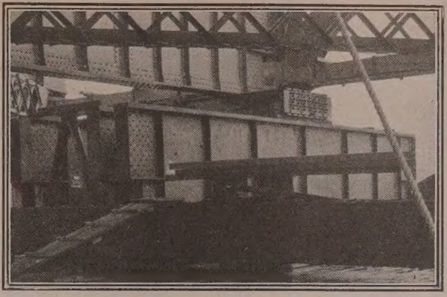


FIGS. 7 AND 8—PINS AND REAR CENTERING PLATES IN PLACE ON NORTH STIRRUP GIRDERS—LEFT, N. W. GIRDER; RIGHT, N. E. GIRDER

treal six steel-frame barges, 32 x 165 ft. and 11 ft. 6 in. deep, able to float the span on a draft of 8 ft. 2 in. Each barge had three longitudinal steel trusses to distribute the load from the span, in addition to transverse steel bulkheads. Each was built with a width equal to one panel length of the span.

Three of the barges, tight together and fastened at each end by two falsework posts laid flat and pinned down to angle uprights riveted to the barge trusses, were floated under each end of the span and brought to rest at low tide on concrete and timber seats. Over the center of each barge was a panel point under which an I-beam grillage parallel to the span rested on permanent floor girders of the span, arranged as shown in the drawings. These girders distributed the load to the trusses of the scows. The scows were wedged down underneath the span and left in place while final arrangements were made for floating. Each of them had six 12-in. valves in its bottom, controlled from the deck. These were left open and permitted the water to rise and fall inside the barges with the tide. The scows were tested out, however, one at a time, to 1 ft. more than their required draft by closing the valves and allowing them to bear against the span.

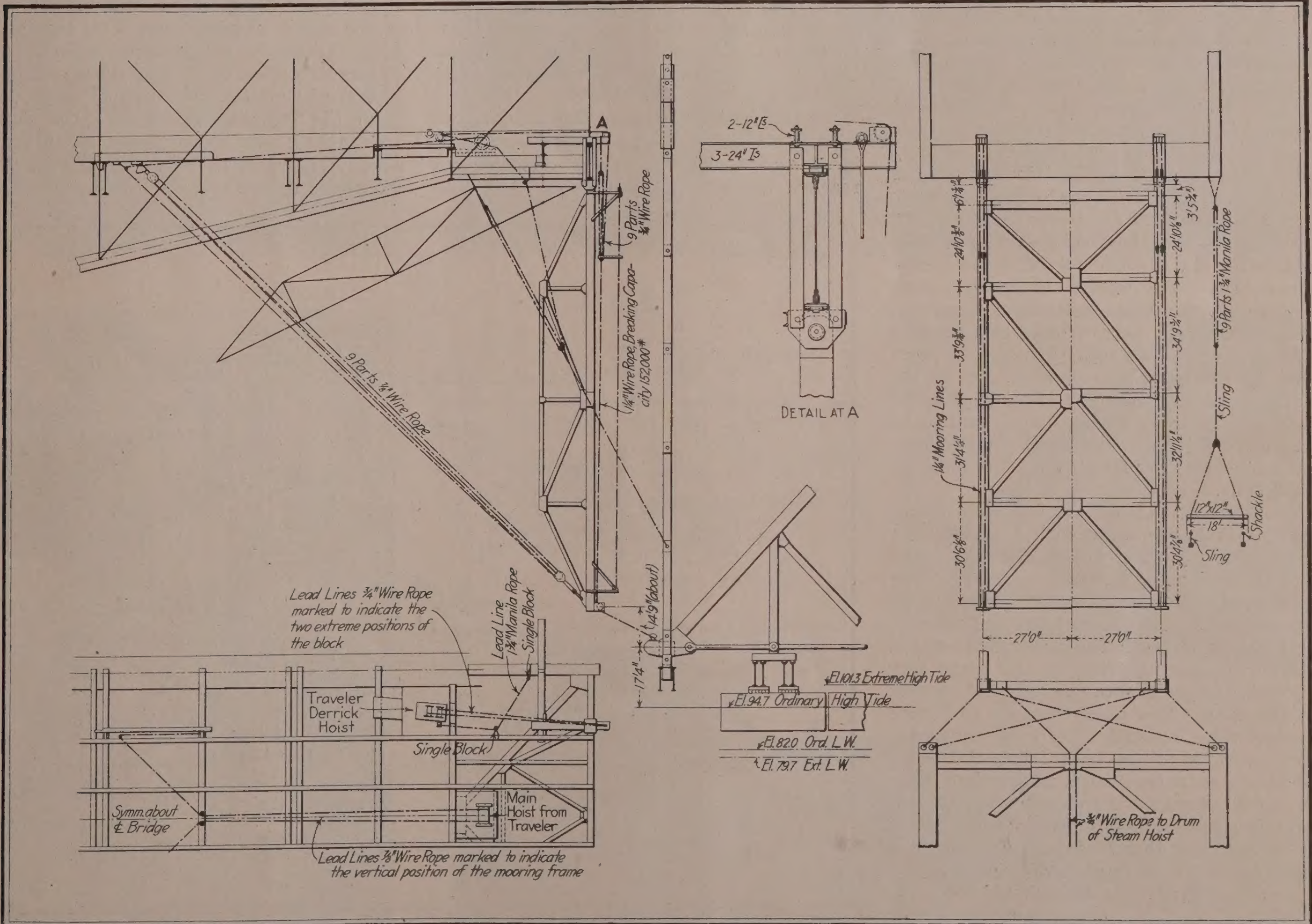
To moor and align the floating span two comparatively light trusses, 130 ft. long, were suspended vertically, one from the end of each cantilever arm. That on the south arm was erected before the traveler was down, and each of its trusses was assembled on the bridge deck and lowered as a unit, suspended from what would be, in a bridge truss, the intersection of the inclined post and the top chord. This caused each truss to hang with its face, corresponding to the bottom chord, at an angle and made it easy to swing it into place for entering the hanger pins.


BLOCKING FROM BARGE TO PANEL POINT

The erection of the north truss was not so easy, as it had to be handled in sections with locomotive cranes. One crane lowered each face member inside the floorbeam till a line outside the floorbeam from the other crane could be attached. With the two lines the member could be hung vertically and raised up to position for connecting with the last piece erected. Both trusses will have to be dismantled in the same way, but in inverse order. From the two lower corners of each were rove 12-part ⅞-in. wire rope falls leading to one of the big electric traveler hoists mounted for the purpose between the bridge tracks. In this way the trusses were swung out far enough to give wide clearance when the span was floated in.

As these trusses were erected, four girders were set across the top-chord members of the cantilever arms, from each of which another girder was hung by heavy rods at the level of the tracks. Resting on each of these girders were two 1000-ton hydraulic jacks bearing a third and movable girder, between diaphragms in each end of which passed long suspender links. These links, each 30 ft. long, had 12-in. elongated holes on 6-ft. centers, and in the bottom of the last one was a 12-in. by 5-ft. slot for slipping over pins in stub links at the corners of the center span. The diaphragms in the movable girders and similar ones in the lower set of girders were provided with three pinholes on 2-ft. centers, so that at any stage of the raising the end of a jacking stroke would bring a hole in the links opposite one of the holes in the diaphragms. The pins thrust in these holes were mounted on long 3-in. rods weighted on the end opposite the pin and counterweighted at the balance point by a weight attached to a wire rope led through a block above. There were 16 of these pins, one for each end of both upper and lower jacking girders at each corner of the span. To prevent any sudden drop or shifting, two heavy screw jacks, shown in the illustrations, were provided to follow up the main jacks. The heavy screws of these jacks were so carefully counterweighted that they could be rapidly turned by one man.

On the outer end of each cantilever arm between the tracks were set two 18 x 2 x 16-in. single-cylinder plunger pumps supplied through independent lines with air at 100 lb. pressure. These pumps drew water from a 60-cu. ft. box into which the jacks discharged. Each pump at each end was able



MOORING TRUSSES AND HANGER CHAINS WERE RIGGED SO THEY COULD BE PULLED BACK TO CLEAR SPAN AS IT ENTERED GAP

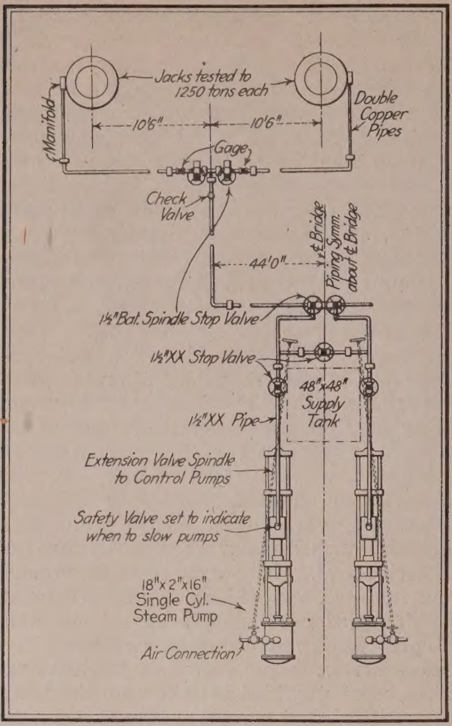

Jacks tested to 1250 tons each
Manifold
10'6"
10'6"
Double Copper Pipes
Gage
Check Valve
44'0"
℄ Bridge
Piping Symm. about ℄ Bridge
1½" Bat. Spindle Stop Valve
1½"XX Stop Valve
48"x48" Supply Tank
1½"XX Pipe
Extension Valve Spindle to Control Pumps
Safety Valve set to indicate when to slow pumps
18"x2"x16" Single Cyl. Steam Pump
Air Connection

DIAGRAM OF HYDRAULIC EQUIPMENT

to run all four jacks in case of necessity, and the piping arrangements shown in the accompanying sketch made it possible not only to cut out either pump but to operate one pair of jacks at a different pressure from that supplied the other pair by the opposite pump. This arrangement was for use in case wind pressure put an unbalanced load on the upstream or downstream side by shifting the hanging span. The control valves at the center in front of the pumps regulated the quantity of water sent to each pair of jacks, thus governing the speed of raising the corners of the span. Similar control valves at each pair of jacks were used to regulate the amount of water sent to each jack, and thus keep the movable jacking girder at each corner level. All pressure control, however, was secured by regulating the throttle valves of the pumps themselves. The entire equipment, furnished by the Watson-Stillman Company, was tested out, a pair of jacks at a time, to 5000 lb. per square inch, 25 per cent overload, by inserting both pairs of pins in the links so as to clamp the lower and upper jacking girders together, and putting a load of 1000 tons on each jack. In addition, each jack had been tested at the shops to 1250 tons.

In front of the operator at each corner was a vertical telltale, with a pointer for each jack, rigged to double the rising and falling motions of the upper girder. Thus it was possible to keep the ends of the girder exactly even. In front of the central control valves on each cantilever arm was a similar telltale showing in the same way the relative position of the adjacent corners of the span. Two pump runners and three control-valve operators on each cantilever arm were required in raising the span, although extension-valve wheels had been provided to enable the operator of the central control valves to regulate the pump throttles, and thus the pressure supplied each pair of jacks, in place of regulating the quantity of water, if this should seem desirable.

In addition to the electric hoist used to pull back the mooring truss on each side, and to the hydraulic equipment, two other hoists were set outside the tracks on each cantilever arm to handle two sets each of the four vertical falls at the corners of each mooring truss, attached to the heavy mooring lines.

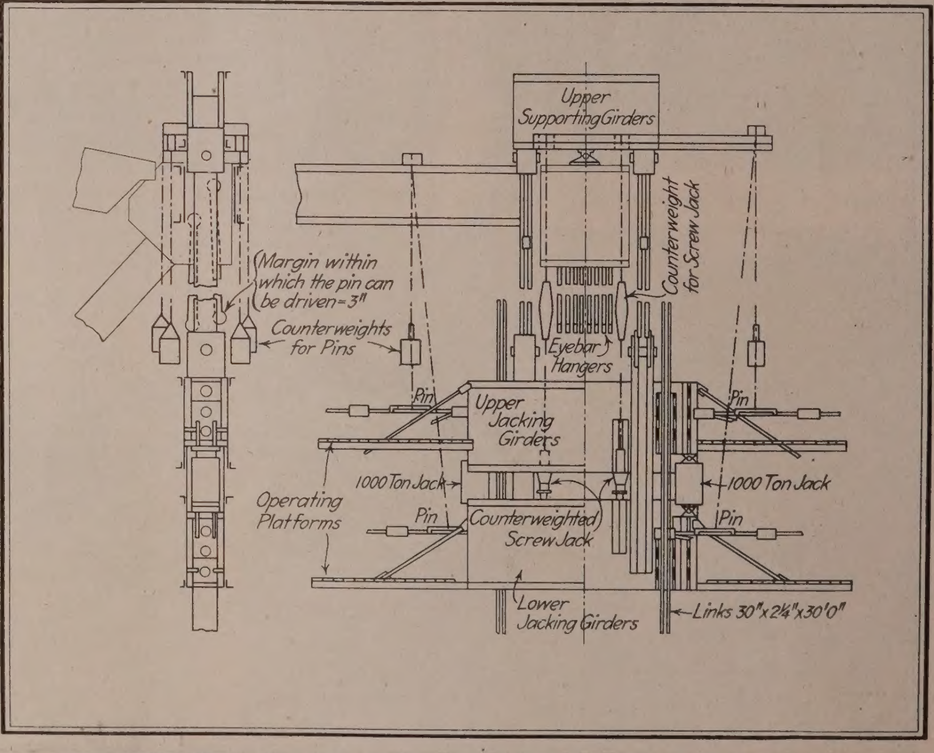
Rigging Carefully Planned

For starting out the suspended span from its moorings at Sillery a set of falls was run from the west inshore corner of the west barge group the length of the end barge to the west outshore falsework tower. To the east inshore corner of the span was attached a 1000-ft. wire cable anchored to a crib downstream from the site. This cable was kept taut and given a square pull on the span by a set of falls run from a point 150 ft. from the corner of the barge to the center of the east end of the span. These falls and the light mooring lines described below were handled by two steam hoists, the only steam equipment besides the locomotive cranes used on the work. One of them was mounted at each end of the span on its center line.

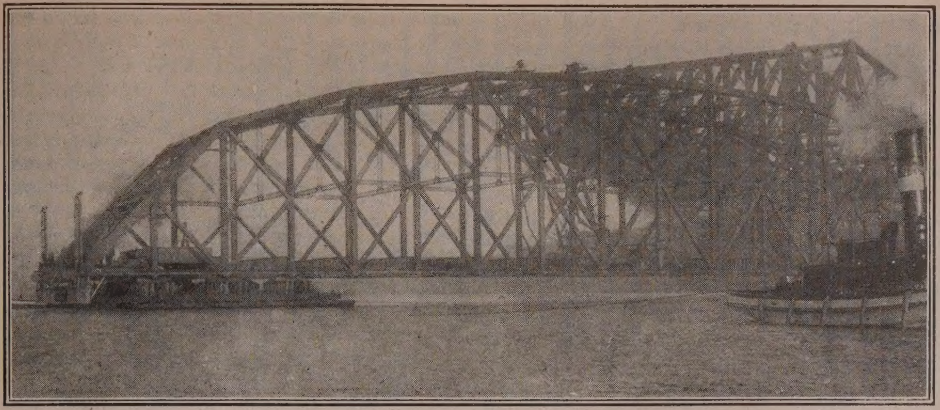
As the span was swung out, snubbing falls on the inshore side were used to control it till clear of the erection site, when they and the pulling falls mentioned were cut away with axes. Swinging about the downstream anchorage of the long cable then continued until the span reached midstream in a position at right angles to the current, by which time a large tug had been attached to the downstream towing shackle, lashed to the center post of the span on that side, two smaller tugs at each corner had taken up lines attached to the downstream towing bitts at each end, and one small tug at each corner had taken up a line attached to the upstream towing bitts at each end. On the trip up the river the downstream tugs backed water most of the time, the two small tugs on the upstream side guiding the span in the center of the channel and keeping it square with the current. As the span reached the site, its center was lined up approximately with balloons hung on the upstream and downstream sides of the bridge midway between the ends of the cantilevers. The five downstream tugs at this point went ahead on their lines, checking the span in the desired position with ease and precision, and without the necessity for any pulling back and forth.

Mooring Lines Painted to Avoid Confusion

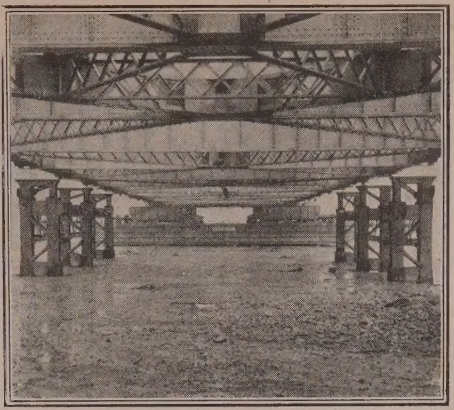
The span reached the site at slack water on the high tide, which lasts under conditions existing at the time about an hour. As it was about 400 ft. from position and drifting slowly upstream a ⅞-in. line from each end was pulled out ahead and thrown over a pin on the upstream side of each mooring truss. As the span, guided by these lines and the tugs, neared the gap, a second light line from the hoist on each end was thrown over a pin on the downstream side of each truss. These lines led through single blocks located near the center line of the span. As the second lines began to lose their slack the 1¼-in. white main mooring line on each end, leading from one of the vertical sets of wire rope falls on the downstream side of each truss, was pulled aboard and thrown over the white mooring bitt on the upstream side at each end of the span. Next the red mooring lines from the upstream side of the mooring trusses to the red bitts on the downstream corners of the span were placed. These heavy lines were crossed beneath the light lines and tightened to assist the tugs in bringing the span to rest in approximate position. During these operations the mooring trusses were swung back to give ample clearance for the entry of the span. They were now lowered slowly as the white and red lines were tightened. A pair of 1¼-in. yellow cables from the upstream side of each mooring truss to the upstream white bitts and a pair of black lines from the downstream side to the downstream red bitts were placed as this was done. This left the truss held with two crossed lines and two straight lines at each



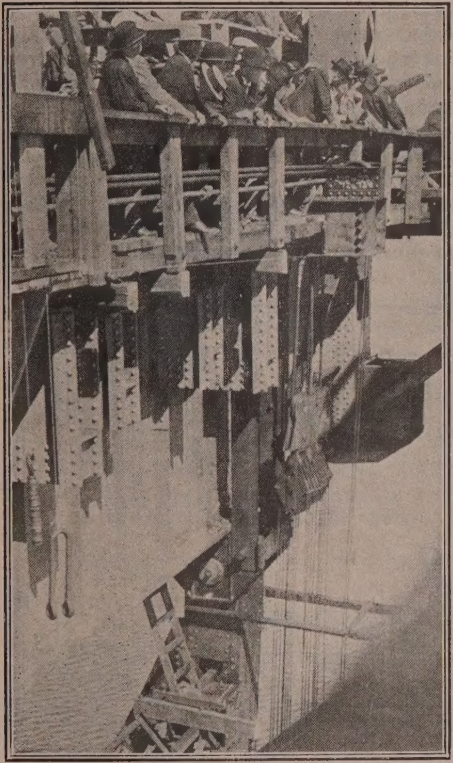
COUNTERWEIGHTING PINS AND SCREW JACKS GREATLY INCREASED SPEED OF JACKING

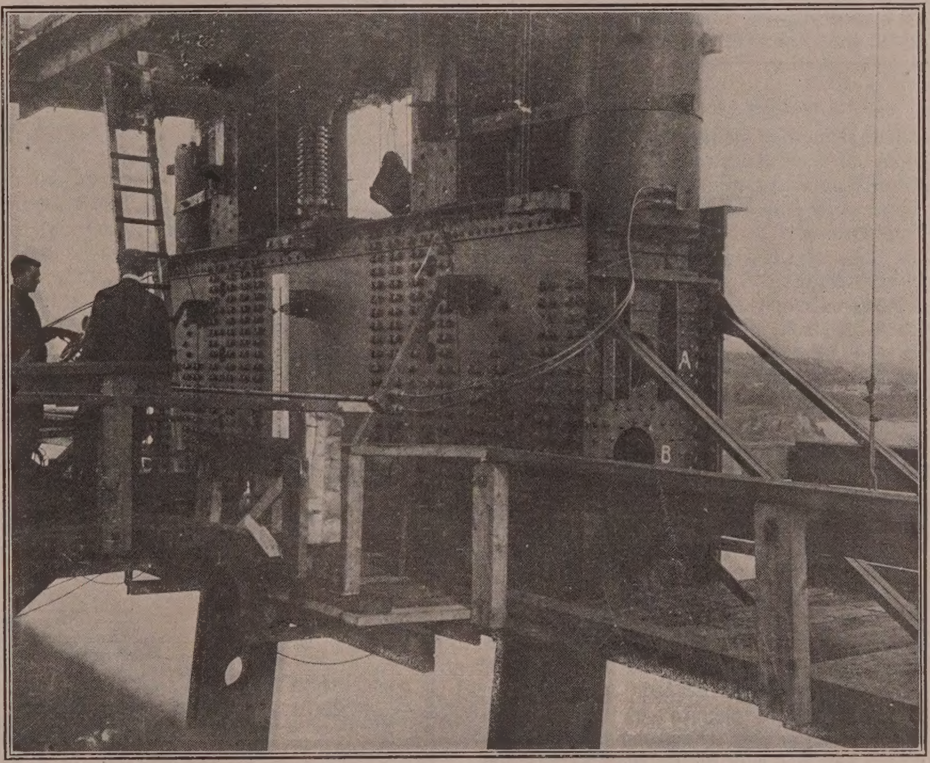


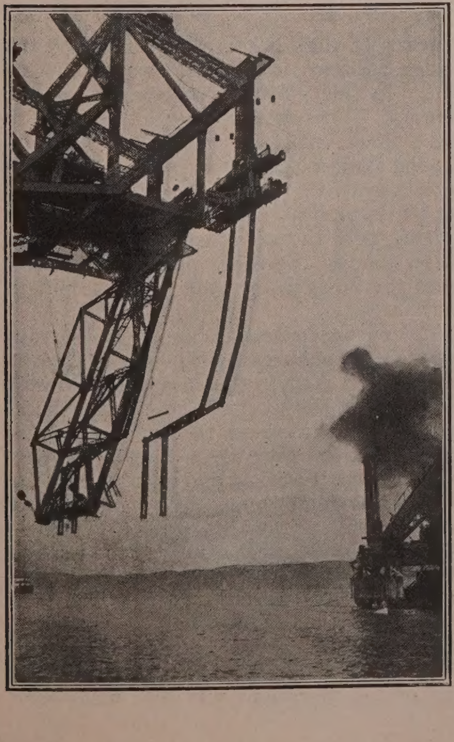
FLOATING SPAN, GUIDED BY SEVEN TUGS, NEARS GAP BETWEEN CANTILEVER ARMS



ERECTION SITE BARE AT LOW TIDE





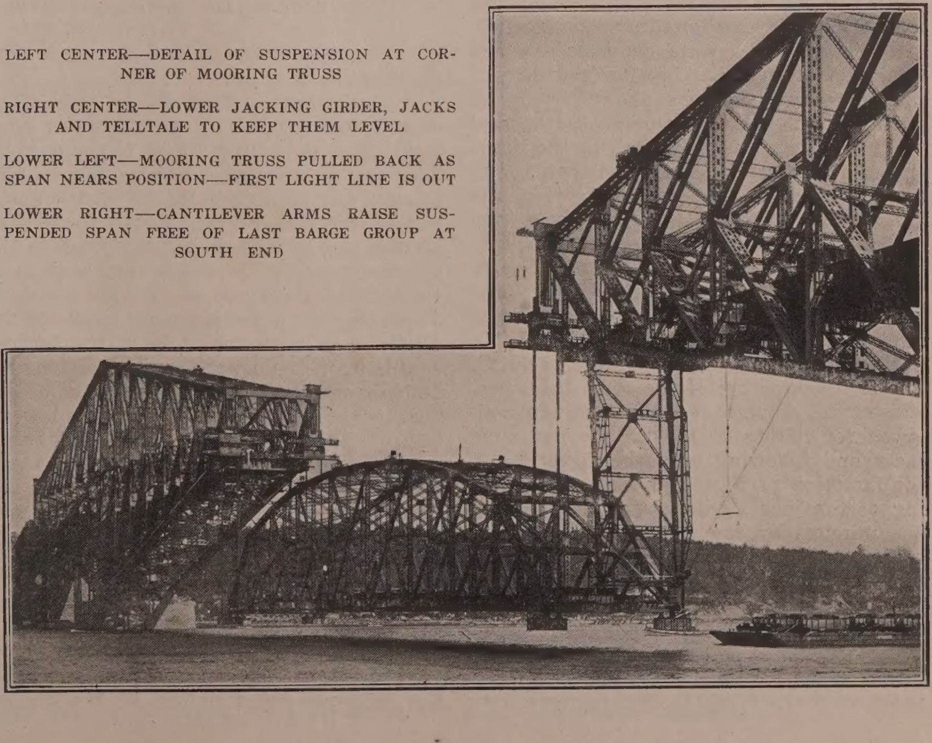


LEFT CENTER—DETAIL OF SUSPENSION AT CORNER OF MOORING TRUSS

RIGHT CENTER—LOWER JACKING GIRDER, JACKS AND TELLTALE TO KEEP THEM LEVEL

LOWER LEFT—MOORING TRUSS PULLED BACK AS SPAN NEARS POSITION—FIRST LIGHT LINE IS OUT

LOWER RIGHT—CANTILEVER ARMS RAISE SUSPENDED SPAN FREE OF LAST BARGE GROUP AT SOUTH END



end, and released the first pair of ⅞-in. lines, which were no longer needed. These lines were used because the falls controlling the heavy lines could be made no longer than the height of the mooring truss, and because it was desirable to have lines out to help the tugs when yet more than twice this distance from the gap.

The falls attached to the four heavy cables at each corner were taken up by the hoists on the cantilever arms and the span was pulled into exact position in a very few minutes. These mooring lines were able, with the tugs, to hold the span in safety against a current of 4 miles per hour acting with a wind pressure of 2 lb. per square foot. The mooring lines and trusses were designed to resist a horizontal pull of 300,000 lb. As previously noted in this journal, elaborate precautions in the way of meteorological observations greatly reduced the chance of any more severe conditions occurring.

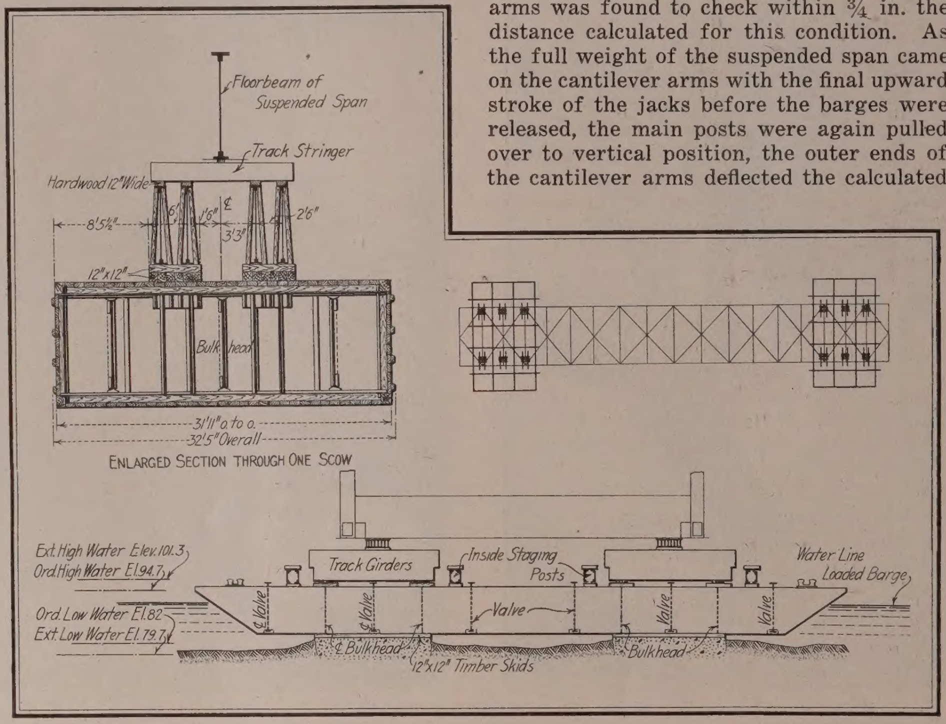
SPAN RAISED ON ROCKER BEARINGS

The slotted suspender links fitted outside those on the corners of the span and were slipped over the pins in the lower set of links while the caps were removed. The links having a ½-in. horizontal clearance in the body of the slot, no pilots were needed for these pins.

Each pair of the stub links was pinned to a box girder of similar design to the girders on top of the corners of the cantilever arms. Beneath the latter girders and on top of the girders under the corners of the suspended span were rocker bearings amply illustrated on another page of this issue. Such bearings were required because it was possible for the span to be swayed as much as 6 in. out of line by wind pressure, and it was necessary to provide for this motion without stressing any part of the lifting mechanism. The stub links and lower girders were suspended by straps between the upper and lower rocker castings, bolted respectively to the span and lower girder, when the span was floated. This arrangement permitted the rocker bearings and girders to center themselves by gravity under the top casting as soon as the span was free of the falsework. While on the trip up the river centering plates holding the castings in this alignment were attached.

After the links were connected—which was accomplished shortly after the turn of the tide—the span was allowed to settle until the pins at the connections dropped 2½ ft. and came to a bearing at the lower end of the slots. Jacking was then begun and the span raised clear, allowing the barges to float out. Breakfast was then served to the men, who had been on duty since 1 o'clock in the morning. Lifting operations were then resumed, and an additional lift completed at each end, making a total of six lifts on the south end and five on the north end up to the time of the accident. The full jacking cycle—including the insertion of the upper pins, the 8 minutes allowed for lifting 2 ft. with the hydraulic jacks and following with the screw jacks, the insertion of the lower pins, the lowering of the jacks, reduced to an estimated 2½ minutes by the use of double copper supply pipes, and the replacing of the upper pins—was estimated to take 15 minutes. This was made on a reduced estimate of the capacity of the main compressor plant, which was relied on to supply air at 100 lb. pressure only fast enough to maintain a pressure of from 3800 to 3900 lb. per square inch during actual raising. As a matter of fact, the main compressor plants in operation proved capable of supplying sufficient air to maintain a pressure in excess of 4000 lb. during the entire upward stroke, and several of the jacking cycles were completed in 10 minutes.

Had the span continued rising, for every 30 ft. a set of suspender links would have been detached above the upper jacking girders and lowered to the deck of the span by the locomotive cranes. It was planned that the permanent eyebar links on the corners of the suspended span would rise during the final stages of the operation between the jacking girders, which were far enough apart to allow the two sets of bars to move away from each other. This motion could of course be followed by the upper links hanging from the cantilever arms. This provided a small vertical variation which would have taken up any slight inequalities in the lengths of the links and made it easy to drive the final pins.



FALSEWORK STEEL REUSED TO STIFFEN BARGES AND FLOOR STEEL TO BLOCK SPAN

A panel length of floor system, half in the center span and half in the cantilever arm, would then have been placed to connect the floor system between the three spans. Expansion has been provided for at the north end of the center span, where these floor girders are to slide in seats riveted to the last floorbeam of the north cantilever arm. In addition there are to be four members connecting the lower end panel points of the center span with the ends of the bottom chords of the cantilever arms, and four redundant members, used for the sake of appearance, connecting the upper chord members of the cantilevers with the upper chord members of the center span. When the bridge is completed the stresses in the lateral system will be transmitted at the ends of the center span by pins placed horizontally below the track level with their long axes coinciding with that of the bridge.

DEFLECTION IN RAISING CENTER SPAN

When the two cantilevers had been erected, there still remained a camber in the bottom-chord members of the anchor arms, leaving them from 0 to 2½ in. below true position. The main posts, which had been erected in vertical position and tipped back 14 in. to permit the last top-chord pins of the anchor arms to be driven, were within 5 in. of vertical. All of the exterior falsework had been released, disconnected from the structure and removed except for two posts under the panel point nearest the anchor pier of each arm. Here the line of camber would have caused a sharp dip in the track grade, to avoid which these two posts were jacked up till the panel point almost reached its final elevation, and wedged with steel plates. This put the vertical tension members from these panel points to the subpanel intersection above in compression. These members were stiffened with posts from the falsework detailed for that purpose. With the two cantilever arms erected and the bridge in condition to raise the suspended span it is said that the distance between the cantilever arms was found to check within ¾ in. the distance calculated for this condition. As the full weight of the suspended span came on the cantilever arms with the final upward stroke of the jacks before the barges were released, the main posts were again pulled over to vertical position, the outer ends of the cantilever arms deflected the calculated distance of slightly more than 8 in. and the bridge assumed its normal dead-load position. In this position the laterals are not stressed. Therefore it was not possible to rivet them until the weight of this suspended span had been taken up. They are now bolted from 50 to 100 per cent at gusset plates and intersections, and will not be riveted until the new suspended span is in place, though it will be necessary to complete this work before the bridge is put in service.

The suspended cages, ample railed runways and platforms which have played so important a part in the speed of this work by relieving the workmen of the strain resulting from working in dangerously exposed positions were again in evidence during the final operation, and must be credited with the saving of many lives at the time of the accident. From the wooden bridge in the center of the suspended span the work of floating and mooring was directed by telephones to each end. As soon as the span was in place these lines were connected to the general telephone system of the job. Perfect co-ordination through central control of the operations was thus made easy.

Tennessee River Hydroelectric Installation Being Completed with Modern Turbines

Special Head Conditions and Power Requirements at Site Govern Original Design and the Present Adoption of Single-Wheel Turbines

REPLACEMENT of two units of the original three-wheel turbine design and the installation of the final four units of the plant with single-runner reaction turbines of the Francis type resulted from the special conditions required for the future operation of the generating plant of the Chattanooga & Tennessee River Power Company at Hales Bar on the Tennessee River. Unusual variation in flow and operating head and uniform power requirements originally determined the design with three wheels on each shaft in order to insure uniformity of output irrespective of variations in head and rate of flow. Ten of the total of fourteen units were manufactured before 1910, but were not put into actual operation until November, 1913, the delay being caused by serious difficulties in the deep foundations of the dam.

A business deal involving an outlet for a large percentage of the plant capacity was recently consummated whereby the current from this plant will augment the capacity of another hydroelectric system, especially during low-flow periods. Hence followed the adoption of single-wheel units of higher efficiency under low-flow conditions for the new installation.

The following short description, with illustrations of the old and the new turbine installations and of the changes necessary in the concrete construction, supplements the description of the work on the original dam and powerhouse foundations given in the Engineering Record of June 10, 1911, page 641.

OLD INSTALLATION

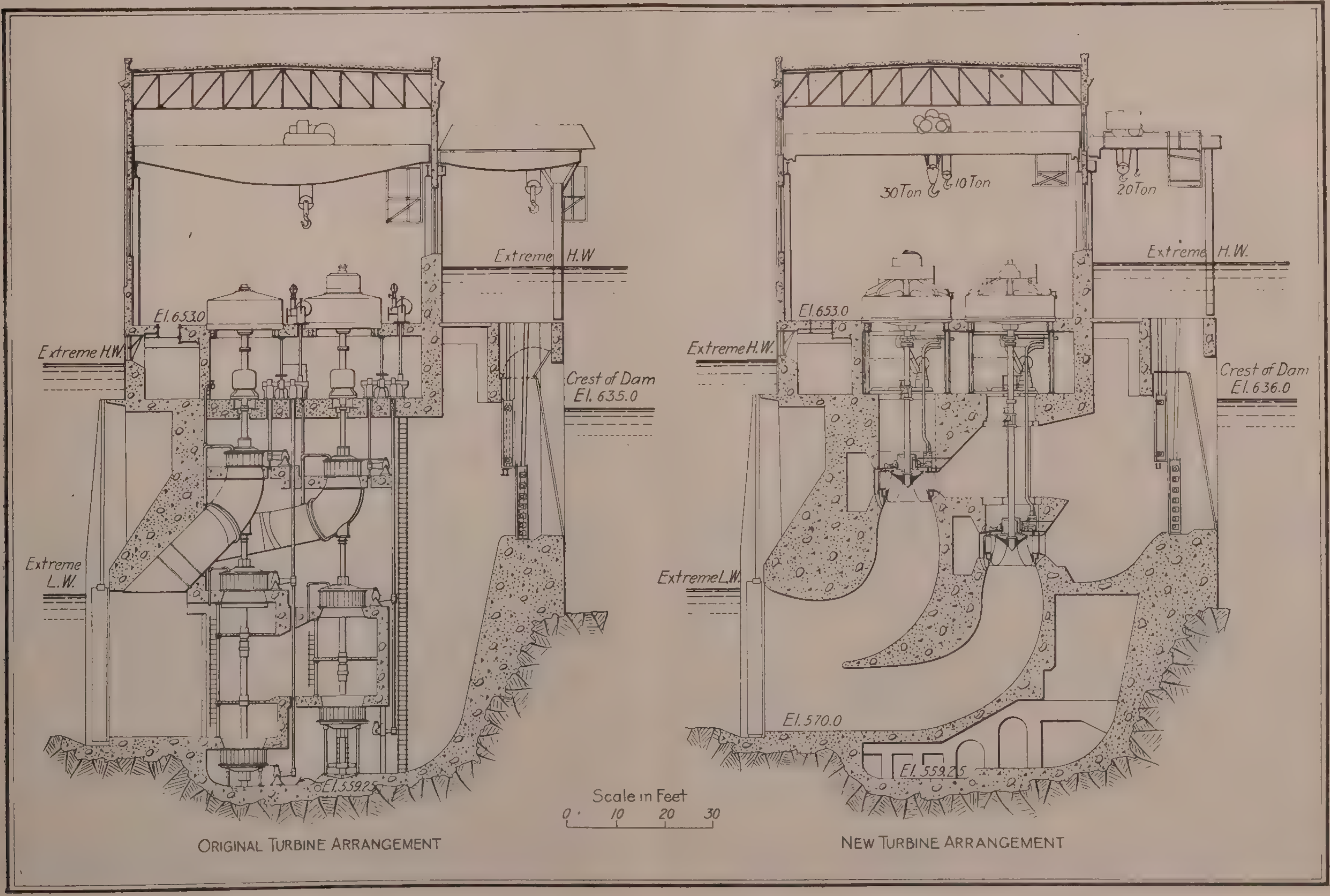
The Tennessee River is subject to the most extreme variations in rate of flow—from a minimum of 6000 sec.-ft. up to a maximum of 600,000 sec.-ft. As the original design was made for the purpose of furnishing the greatest possible uniformity of output even under varying hydraulic heads, ranging from 39.5 ft. at low water down to only 19 ft. under conditions of extreme flood, an arrangement of three waterwheels on each shaft was selected, as shown. These were designed to enable the plant to maintain relatively high output throughout the 20-ft. variation in hydraulic head, and especially under low heads occurring at flood periods. Under normal conditions the two lower 72-in. turbines are used, the third or upper 63-in. unit coming into operation when high water reduces the operating head.

The new conditions which caused the modification of this design when the new units were planned have already been suggested. In brief, the situation involved the delivery of current by the Hales Bar station to increase the capacity of another hydroelectric system, especially during low-flow periods. As the available head at Hales Bar varies inversely with the stream flow, and as the other system is operated under conditions where hydraulic head increases with flow, the linking of the two systems is obviously beneficial, and the main requirement of the new installation is high efficiency under the high heads occurring at low stream flow.

After a number of models had been constructed and tested at the Holyoke station, with particular reference to the special conditions to be met, the new turbines were designed and installed. As indicated by the drawing, in place of three turbines on each driving shaft, a single-runner inward and downward flow reaction turbine of the Francis type, of 82-in. diameter, is used. These single turbines have less capacity than the 5090-hp. three-runner type originally planned, and the output at low heads is very much less. At high heads occurring under low stream flow, however, the new turbine efficiency is very much greater. Although the capacity of the new turbines is less, the capacity of the new generators was retained at 3750 kw. as originally contemplated, giving a liberal margin for operation at low power factors.

CHANGES IN CONSTRUCTION

Comparison of the concrete construction shown in the drawing herewith indicates the nature of the remodeling necessary to install the new units. Much of the original concrete was cut out, and wooden forms were used for the new carefully molded concrete scroll cases and the reinforced-concrete draft tubes leading to the tailrace. The new wheel-pit is thus of monolithic construction, designed to guide the



SECTIONS SHOW ORIGINAL AND NEW ARRANGEMENTS OF TURBINES OF TENNESSEE RIVER POWER DEVELOPMENT water from intake to tailrace with the least possible friction losses.

The efficiency of the new turbines was demonstrated in tests recently made. They give outputs at all stages better than the manufacturers were willing to guarantee. Both output and efficiencies are equal to those deduced from the Holyoke tests. They give the results desired under the new conditions as indicated above, not only at the high heads, but down to as low heads as have occurred since these wheels were installed. These new turbines, with the monolithic water passages and the new generators, afford one of the best recent examples of hydroelectric development.

The turbines were built by the S. Morgan Smith Company, the generators by the General Electric Company. The hydraulic and mechanical installation was designed and supervised by John Bogart, New York City, consulting engineer of the Chattanooga & Tennessee River Power Company, the electrical work being done under the direction of T. E. Murray, of New York City, consulting electrical engineer of the company.

Railroads Rework Car Lumber

Following the example of the Chicago, Burlington & Quincy Railroad, which has been able to realize $20 per car by resawing the lumber in condemned rolling stock, the Baltimore & Ohio Railroad has established a resawing plant at Cincinnati. The mill, which cost $7,500, will rework lumber reclaimed from dismantled freight-car equipment, old bridges, trestles and other railroad structures. It is estimated that the plant will save $50,000 a year. The worked-over lumber is used for buildings, platforms, bins and other railroad structures.

Open Scenic Highway Over Continental Divide in Southwestern Colorado

Highway Mileage to Los Angeles Shortened Materially and a 30,000-Square Mile Area of Scenic and Economic Value Made Easily Accessible at Small Cost

WOLF CREEK PASS over the Continental Divide in southwestern Colorado, the last connecting link in the Spanish Trail, was opened to automobile traffic in August. The construction of the 16 miles up the South Fork of the Rio Grande and 14 miles down Wolf Creek on the west slope involved many heavy cuts, fills, bridges and sharp curves, and three years' time. The southwestern corner of the state where Utah, New Mexico and Arizona also join is particularly rich in mountain scenic beauty, cliff dwellers, mines and Indian country, to say nothing of mineral and agricultural resources—all hitherto quite inaccessible. The new road makes all this available to the tourist by automobile, the railroad time to such places as Pagosa Springs across the range being cut by six hours. It also completes a diagonal 600-mile state highway almost directly from the northwest corner to the southwest corner of the state, connecting up Julesburg, Denver, Colorado Springs, the San Luis Valley or Pueblo, and the Rio Grande Valley. It also shortens the road to Southern California about 300 miles—a feature that means much to tourists, particularly as the scenery is said to excel that on any other transcontinental route.

HAIRPIN OF 30-FOOT RADIUS TURNS AFFORDS AMPLE TURNING ROOM

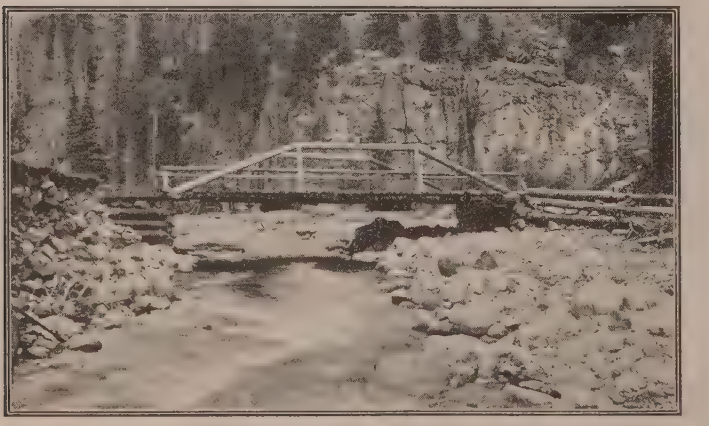
SWITCHBACKS GAIN ELEVATION FAST ON WEST SIDE OF DIVIDE

Much Road Above Water Grade

Choice of alignment over the pass was dictated in most cases by topographic conditions and the 6½ per cent ruling grades. On the east side, however, water grade was left in two cases and the alignment placed from 200 to 500 ft. above the stream level to keep it out of prospective reservoir sites. Nine miles down from the top is a particularly heavy section cut from the sheer rock as the road rises to traverse a natural park 4 miles long where the construction was simply grading. In the last 4-mile stretch up the east side the necessity of gaining the top involved almost a constant adherence to the 6½-per cent ruling grade, with occasional short stretches up to 7½ per cent and eight hairpin curves with a 30-ft. radius. Long wheel-base machines cannot turn easily on a smaller radius. At a dozen points boggy spots of black humus 30 to 150 ft. long make heavy roads the first season, especially since rainstorms are the rule every afternoon.

Starting from the west side, elevation was sought at once from the comparatively flat San Juan Valley by two switchbacks. For construction reasons and because of the series of waterfalls in the creek the road on this side rarely is near the water grade. As it is, there are numerous cuts through sheer rock.

At the top for 2 miles the road is on light grades through a grassy park in the saddle of the water shed at 10,860 ft. above sea level. The total rise is 2360 ft. On account of the boggy nature of the center of the saddle the alignment follows a winding contour along the north side, where good material is available.



QUEEN-POST BRIDGE WITH CRIB ABUTMENTS BUILT ON GROUND

EACH RAVINE, HOWEVER CLOSE IT COMES, MUST HAVE ITS BRIDGE

ROAD ALIGNMENT IS ALONG UPPER PART OF 40-FOOT CLEARING

ROAD FOLLOWS SIDE OF SADDLE OF PASS TO AVOID THE MORASS

Available funds precluded the construction of a road wider than 14 ft., including the drainage ditch, and in some of the heavier sections the west side is only 10 ft. All of the east side is 14 ft. Turnouts at intervals of at least 1000 ft. will be constructed with the first available money, particularly on the narrower sections. As the rules of the road generally adhered to in the mountains is for the driver coming up to wait at turnouts and to back to one if he is caught between them, this work will be demanded at an early date.

The road is graded flat toward the bank side, where a longitudinal ditch carries the hillside seepage and surface water falling on the road to culverts spaced about 500 ft. apart on the steepest slopes.

Log Bridges Used

For economy all bridges are of log construction. Everything had to be packed in. There are no bridges longer than 40 ft., and these are at the junction of the Middle Fork and the South Fork, about 9 miles from the top on the east side. They are of the queen-post type, 20 ft. wide, with a deck of 4-in. plank hewn from red spruce resting on six log stringers having about 12-in. butts. One-inch rods support the cross-logs at the panel points.

Two smaller bridges were carried out last winter by a 7-ft. snowfall, and many of the other bridges had the handrails broken by slides down ravines. In most cases little damage was done the road as the slides went over it. From Dec. 1 to April 15 the roads will be closed on account of snow, and even at the latter date it will require a gang of men to clear the road. Log culverts only have been placed, although the engineers realize they will not last more than a few years, when they will likely be replaced by corrugated-iron pipes buried at least 12 in.

About 60 per cent of the road is surfaced from rock found *in situ*, but as more money is available the remainder will be covered with 3 to 6 in. of disintegrated granite, which is easily obtainable.

Clearing Right-of-Way

Clearing of the 40-ft. right-of-way was the first operation after the engineers got the line staked out. The road is built on the upper contours of the right-of-way, for the felled trees were easiest pulled downhill, where ultimately they will be piled and burned to conform to the requirements of the Forestry Service, through whose domain the road traverses.

Maintenance of the road is paid for by the state and will be handled by a man and team with road drag on each side. The road will be dragged often. Soft spots will be resurfaced with broken stone or else dug out, drained and filled in with crushed stone. The black muck from the humus absorbs water like a sponge, and underground drainage or entire removal is essential to make a permanent all-weather road.

It is proposed this fall to permit, and even to encourage, the driving of sheep over the road to compact it. A saving of $26 per carload can be effected by driving over the divide to the railroad at South Fork, and about 100,000 sheep will be shipped out this fall. Permission from the Forest Service to pass these animals and feed en route is necessary, as the Service has now restricted the herding of sheep for some distance back from the road and has given citizens the privilege of renting cabin space for 10 years at desirable points. This is in line with the department's efforts to make the forests of fullest use to the public.

Construction Methods Simple

Three contractors carried out the construction on the 30 miles of pass proper—C. J. & L. J. Chapman and A. G. Fassett, Logan & West, and Harry Hokasano. No unusual methods were used, the greatest difficulty being to get in supplies for the small crews employed. On heavy rock work on the east side a Sullivan steam drill was used. At one point a block as large as a freight car was precipitated 100 ft. to the river bed by 150 lb. of black powder in five holes 12 ft. deep. The grade had purposely been adjusted to come at a seam at the base of the block so that the powder practically built a finished stretch of road. Just above

WALLS 2 FEET WIDE AT BASE ARE LAID DRY AS HIGH AS 25 FEET

PROFILE OF HIGHWAY IS ADJUSTED TO COME AT SEAMS IN ROCK the rock cut occurs the heaviest fill, 25 ft., back of a dry stone wall 2 ft. wide at the bottom and sloping in at the top 1½ in. per foot. All embankments are of similar construction.

Construction necessitated maintenance as soon as the road was completed, and the contractors put on a team with drag for this purpose.

The condition of the road Aug. 21, the day of its formal opening by the governor and 500 road enthusiasts at a point half way up the east side, was good. There was low-gear pulling on the grades and in the short soft stretches, but there was always bottom, and the Denver Chamber of Commerce official car—in which a representative of the Engineering Record rode—made stops only for the photographs shown herewith. This season's traffic and the proposed sheep drive will make a boulevard surface for the 5000 out-of-state tourists who will travel over it next year. The cost of the 30 miles to the state averaged only $3,000 per mile. The heaviest mile involved 6000 cu. yd. of rock excavation and about 4000 cu. yd. of earth handled.

The road was built under the supervision of a board of construction, R. A. Chisholm, Fred Catchpole and A. L. Moss, representing the four counties interested. W. W. Reilly was the resident engineer, and all plans and work were approved by the engineer of the State Highway Commission, J. E. Maloney. Lon Mitchell, Mr. Reilly's predecessor, was drowned in 1913 while making surveys. The work was financed entirely from the state road fund under apportionments made by the commission, of which T. J. Ehrhart of Denver is the state highway commissioner. C. E. Herr of Durango, a former member of the advisory board for the district in which the road is situated, had much to do with the completion of this important link. Fred Goble of Silverton is at present the advisory board member from this district.

Canadians Object to Choice of American Engineer

Engineers' Society, to Prevent Recurrence, Urges Members to Protest to the Government and Men of Influence

RECENTLY a commission was appointed to study the railway situation in Canada. Its members are A. H. Smith (chairman), president of the New York Central Railway; Sir Henry Drayton, chairman of the Railway Commission of Canada, and Sir George Paish, the eminent London financier. The commission, as was noted in this journal for last week, has selected George F. Swain, professor of civil engineering in Harvard University and chairman of the Boston Transit Commission, to take charge of its valuation work. This appointment has been criticised by the Canadian Society of Civil Engineers on the ground that a Canadian should have been elected. The council of the society is sending to all members a circular urging them to protest to the government and to others of influence in order to prevent the recurrence of similar instances.

The circular is printed here in full:

Circular of Canadian Society

"The council of the Canadian Society of Civil Engineers desires to call your attention to a matter of vital interest to the society, and requests your personal action in connection therewith for the benefit of the civil engineers of Canada.

"The Canadian Government, as you are aware, recently appointed a commission to advise upon certain phases of the railway situation of the country. It is understood that the government wishes to determine whether it should continue to assist private ownership as in the past by additional loans, or take over for itself the ownership and operation of certain railways, or allow them to go into receivership. The commission consists of Mr. A. H. Smith, president of the New York Central Railway; Sir Henry Drayton, chairman of the Railway Commission of Canada; and Sir George Paish, financier, London, England.

"The above commission immediately appointed an American engineer as its adviser, and instructed him to organize a corps of engineers for valuation and advisory work. We wish to record our strong condemnation of the policy of placing in the hands of aliens the engineering work of a commission appointed by the Canadian Government to investigate Canadian railways for which the Canadian community has paid.

"The inferences to be drawn from the employment of aliens in the above connection are that the federal government considers:

"1. That the Canadian engineers who built the railways are not competent to report upon them.

"2. That the Canadian universities, in many cases enjoying government subsidies, are not producing competent engineers; and

"3. That the Canadian Society of Civil Engineers, although embracing a membership of about three thousand, is not considered worthy of consultation on an important engineering question.

NOT FIRST OCCURRENCE

"The above-mentioned appointment of alien engineers is not by any means the first of its kind, as many similar but possibly less flagrant cases have preceded it, and it is not improbable that the recurrence of such appointments may be due to the fact that Canadian engineers neither assert themselves nor demand recognition.

"In order to impress upon the federal government the fact that one of its first duties is to encourage and develop the engineering profession in Canada in every possible way, the council has selected this gross violation of a vital principle to initiate a campaign and impress the fact that Canadian engineers must receive due consideration. The Canadian railways, canals, public works and other engineering attainments are a proof that Canadian engineers stand in the front rank, and it should be quite unnecessary for them to have to appeal to their own government for recognition.

"It may be argued in support of the present alien appointment that Canadian engineers are not acceptable because many have been in the employ of the railway companies. To this we would reply that, as the commission itself is to advise the government, basing itself upon the engineering data given to it, any experienced engineers are competent to collect and submit the necessary information to the commission.

TO WHOM TO PROTEST

"It may also be argued that the government gave the commission a free hand in the appointment of an engineering staff, and since this freedom of appointment is essential, our protest should be to the commission itself. To this we reply:

"1. That when a particularly flagrant case arises such as this, where competent constucting and operating engineers are passed over in favor of alien engineers, the question of the suitability of the commission appointed by the government for the work in hand comes into question.

"2. A protest to the commission itself would probably prove futile, and, even if successful, would not in any way impress the government, the creator of commissions, in regard to future procedure in matters of this kind.

HOW TO PROTEST

"The council of the Canadian Society of Civil Engineers, therefore, asks you to use your influence in every way to diffuse a knowledge of this matter throughout your community, and to place before those with whom you may come in contact the facts of the case and the position of engineers in relation thereto. Specifically, the following is recommended:

"1. That you write to your representative in the Dominion Parliament, whether Government or Opposition, setting forth the facts of the case in a strong way, and pointing out that this is merely an incident in a long course of similar procedures.

"2. That you write in a similar vein to those having influence with the government in your own community or elsewhere.

"3. That wherever similar incidents are brought to your attention you voice a protest, giving the facts to your local branch of the Canadian Society of Civil Engineers or to the secretary at Montreal in such a manner that the council may deal therewith.

"4. That you do not delay acting in this matter as above outlined, but proceed today to do what you can to bring every pressure to bear in every direction for the good of the engineering community in Canada.

"The council requests that you will be good enough to fill out and return the accompanying blank to your branch or to headquarters if you are not a branch member, in order that they may be fully aware of what has been done by the membership at large toward strengthening such representation as it may seem desirable to make to the Dominion Government."

CHARACTER OF BLANK

The blank inclosed with the circular provides space for the names of federal representatives to whom the member of the society has protested, and also the names of men with influence in Ottawa with whom the member has taken up the matter. There is a division also for the listing of instances of the engagement of "outside engineers" which the member considers "not fully justified."

Fluorescein Used to Trace Seepage

Fluorescein has been successfully used by the engineering department of the city of Portland, Ore., for tracing the course of seepage through the pipes in the western parts of the city. It has been found that fluorescein will not oxidize as readily as dye material or permanganate, usually used for this purpose. The method of using the fluorescein is identical with the common methods used with the other chemicals, and its only advantage is said to be the fact that it oxidizes less when the underground flow involves a considerable lapse of time.

WEST END OF HOPPLE STREET VIADUCT COMPLETED OVER BALTIMORE & OHIO RAILROAD

Hopple Street Viaduct, Cincinnati, Is Built with Cantilever Beams of Arch Form

Skew Reinforced-Concrete Superstructure Supported by Concrete-Pile Foundations—Layout and Reasons for Design Presented

By EDGAR K. RUTH
Assistant Professor of Civil Engineering, University of Cincinnati

HOPPLE STREET VIADUCT, now nearing completion in Cincinnati, is an example of the cantilever principle applied to the design of an arched reinforced-concrete bridge. A few large bridges, notably the Washington Street bridge, Norwalk, Conn., and the Hanover Street bridge, Baltimore, have been built with structural-steel cantilever ribs incased in concrete. The Hopple Street viaduct, however, contains no structural steel; its cantilever ribs are true reinforced-concrete girders.

The viaduct proper is about 2000 ft. long between end abutments, and rests upon twenty-six reinforced-concrete piers, spaced from 65 to 80 ft. apart, all skewed from 59 to 78 deg. The superstructure, consisting of a 46-ft. roadway with two street-railway tracks in the middle, is carried on four lines of longitudinal girders, or ribs, with arched soffits, so that the viaduct appears to be a succession of true arch spans on rather slender abutments. Actually, however, a joint cuts completely through the structure at the crown of each apparent arch, thus dividing the viaduct into a series of monolithic cantilever units, each consisting of a pier and its balanced cantilever ribs. These joints are designed to distribute concentrated loads from one cantilever to the adjacent one, and to take care of expansion and contraction in the concrete. At these points double cross-beams connect the ends of the ribs on each side of the joint. A 9 x 10½-in. block projects from the side of one cross-beam along its full length into a corresponding recess in the side of the adjacent beam. Horizontal movement is allowed for by a 1-in. space between vertical surfaces filled with a layer of tarred felt. The horizontal surfaces of the joint are separated by three layers of heavy tar paper.

HISTORY AND LAYOUT

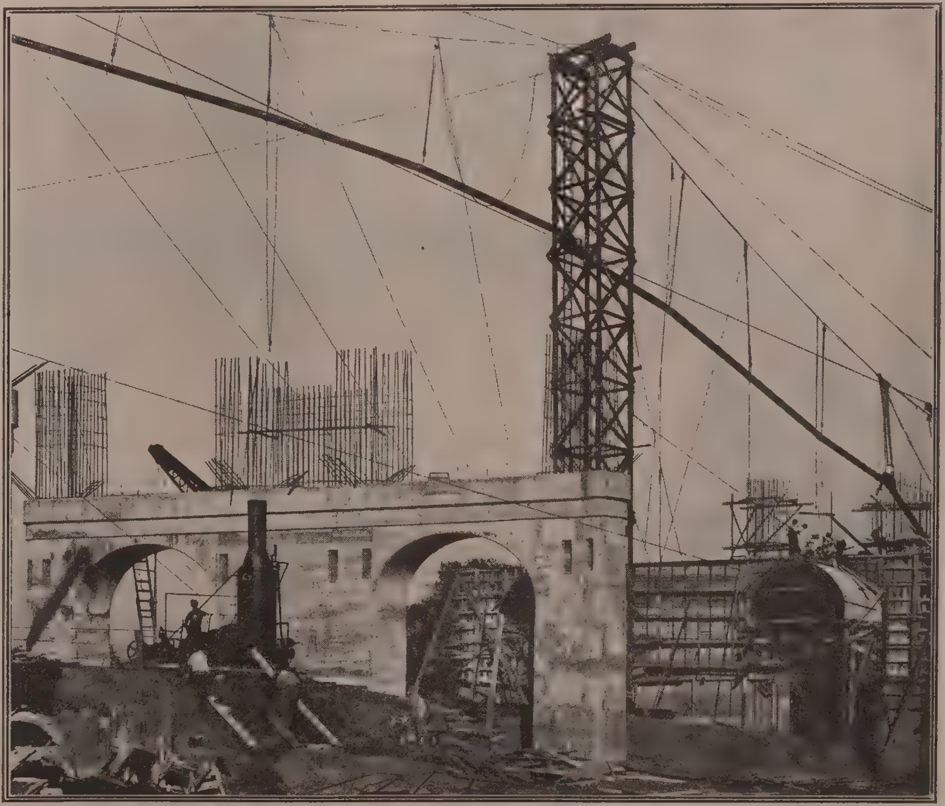
Before taking up the reasons for the adoption of the cantilever design, the details as to the loads assumed, and the allowable working stresses used in the computations, a brief description and history of the viaduct will be given. It is the longest of three large reinforced-concrete structures built by the city of Cincinnati since 1911 in connection with its extensive program for the elimination of all dangerous grade crossings within the city limits. It eliminates the grade crossing of the several tracks of the Baltimore & Ohio Railroad at Hopple Street, and is being built by the city in co-operation with the railroad under a joint agreement in accordance with the provisions of the state grade-crossing elimination law, which at the time the agreement was signed provided for an equal division of cost between the railroad and the municipality. This law, however, has since been amended so that the railroads must pay 65 per cent of the total cost of all such projects. The custom had previously been established that the municipality should prepare the plans and have charge of construction wherever it was found necessary to raise the street over the railroad, the railroad to have charge where conditions were such as to require the elevation of its tracks or the lowering of the street, or both.

The existing width of Hopple Street being 40 ft., the Baltimore & Ohio Railroad agreed to pay 50 per cent of the cost of a viaduct 40 ft. wide. The city, however, desired to widen Hopple Street to 60 ft. so it could be used as the connecting link between the extensive park and boulevard systems projected by the Park Board for the eastern and western portions of the city, as well as to allow future street-railway extension out of Hopple Street as an emergency route in time of high water, when all existing lines to the northwestern suburbs are put out of service.

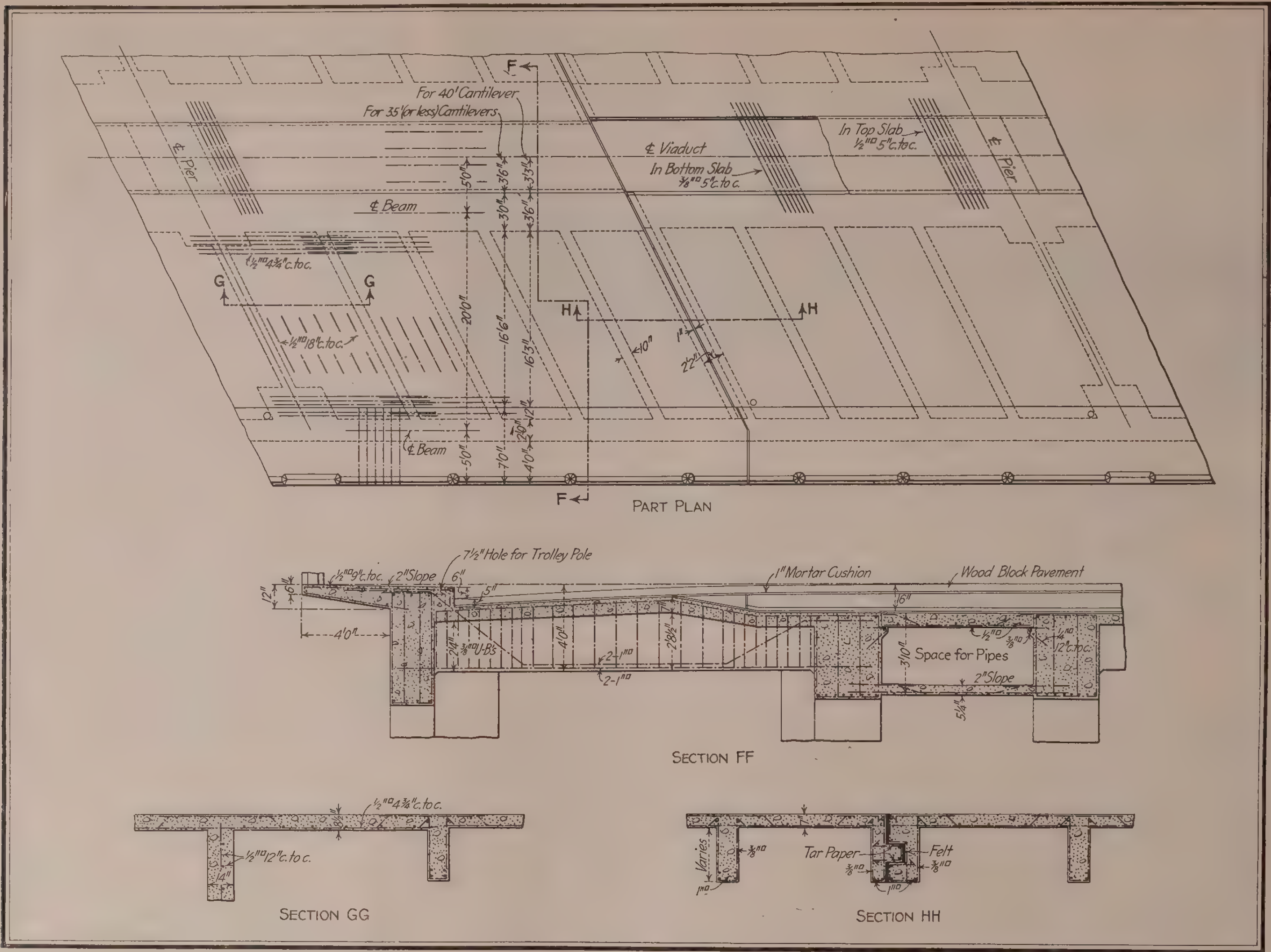
The plans as finally agreed upon by the city and the railroad called, therefore, for the widening of Hopple Street from 40 ft. to 60 ft. between Meeker Street and Beekman Street, the city to pay the entire cost of the necessary property, and the construction of a reinforced-concrete viaduct 60 ft. wide, of which the city was to pay two-thirds and the railroad company one-third of the total cost. Damages to abutting property were shared equally.

GENERAL DESIGN REQUIREMENTS

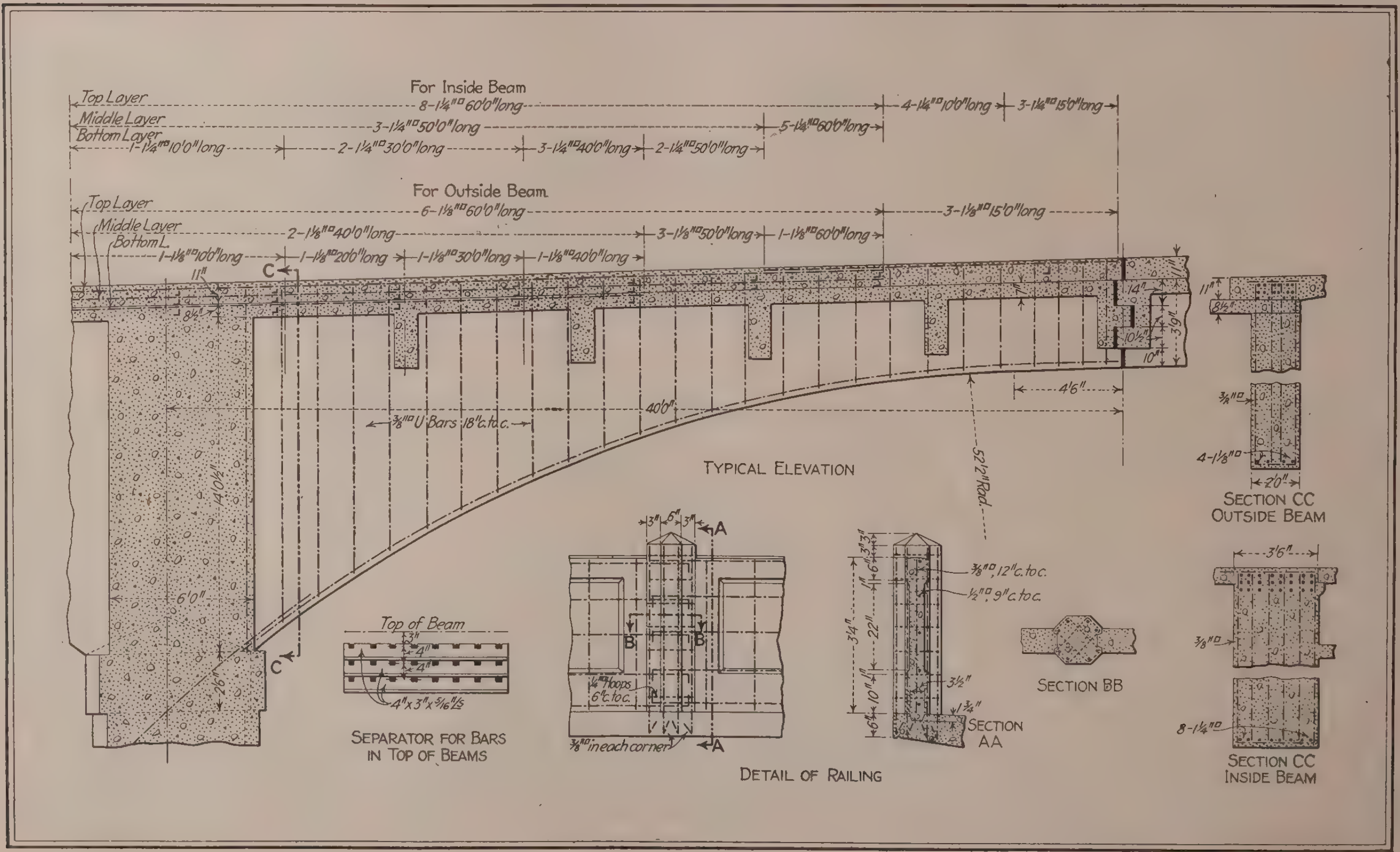
The general design of the viaduct was determined by the character of the pier foundations, indicated by wash borings taken along the site, and by the fact that the railroad already had well-developed plans for extensive storage yards west of its present tracks, over which the viaduct must pass for more than 1000 ft. A maximum grade of 2.7 per cent was required to obtain the necessary clearance over the



STEEL FORMS USED IN PIER CONSTRUCTION—REINFORCEMENT PROVIDED FOR UPPER SECTION



PART PLAN AND CROSS-SECTION OF BEAM-AND-SLAB ROADWAY, SHOWING SKEW CONSTRUCTION AND REINFORCEMENT



TYPICAL ELEVATION OF HALF CANTILEVER RIBS, WITH SECTIONS OF INSIDE AND OUTSIDE BEAMS future hump tracks of the yard. It was necessary to carry four piers at the west end down for more than 50 ft. below the ground surface in order to go below the proposed new channel for Mill Creek, which the railroad plans to divert about 500 ft. west of its present location. These four piers, as well as three others at the present location of Mill Creek, rest on solid rock about 10 ft. below the creek bed. Rock being so far below the surface of the ground, and the soil being mostly either soft blue or yellow clay, it was decided to support all the other piers on concrete piles.

CANTILEVER DESIGN

The cantilever design was decided upon as the one which would best eliminate damage to the structure in case of unequal settlement of the piers resting on piles. Also, for architectural effect, it was desired to retain the arched form of the superstructure, which the cantilever design made possible without having to contend with the effects of arch thrust, temperature change, rib shortening, etc.

Pier spacings of 70, 75 and 80 ft. were selected as best conforming to the railroad company's track layout. A 70-ft. span was made by combining two 35-ft. cantilevers, a 75-ft. span by 35 and 40-ft. cantilevers, and an 80-ft. span by two 40-ft. cantilevers. This arrangement was necessary in order to keep the cantilever ribs of each pier balanced as to dead load and keep it symmetrical about the pier center line. The center of gravity of all dead loads was thus kept at the center of the pier, and all bending stresses were eliminated from the piers except those resulting from unbalanced live loads.

LIVE LOADS AND ALLOWABLE STRESSES

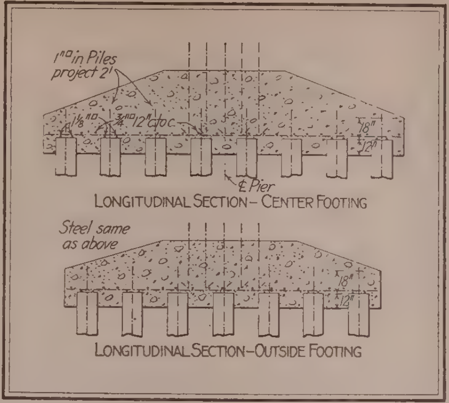
The live loads were assumed as follows: Each of the interior cantilever beams was designed for the maximum stresses produced by a moving load of two 40-ton electric cars entrain, each car being 45 ft. long overall, with two four-wheel trucks 19 ft. 6 in. on centers, 25 per cent being added for impact. The outside cantilever beams were designed for 100 lb. per square foot on the sidewalk and 150 lb. per square foot on the 8-ft. strip of roadway adjacent to each curb. The roadway slab was designed for 600 lb. per square foot, and the cantilever sidewalk for 100 lb. per square foot. The beams were designed for the maximum stresses produced by a 20-ton road-roller, with 20 per cent added for impact, two-thirds of the load resting on the rear rollers, 7 ft. center to center, the front and rear axles being 11 ft. apart.

In designing the piers and footings, maximum stresses were obtained by assuming the superstructure supported by any one pier as loaded with its full live load on one side only. The piers and footings were heavily reinforced to resist the bending-moment stresses produced by this extreme unbalanced condition of the live load.

The maximum unit stresses allowed in proportioning the various parts of the viaduct are given in the accompanying table.

ROADWAY AND WATERPROOFING

The roadway of the viaduct is paved with wood block laid on a cement-mortar cushion, mortar being used instead of sand, as originally specified. Street railway tracks bolted to steel ties were laid in a depression of the roadway slab and surrounded with concrete ballast.



TYPICAL SECTIONS OF PIER FOOTINGS

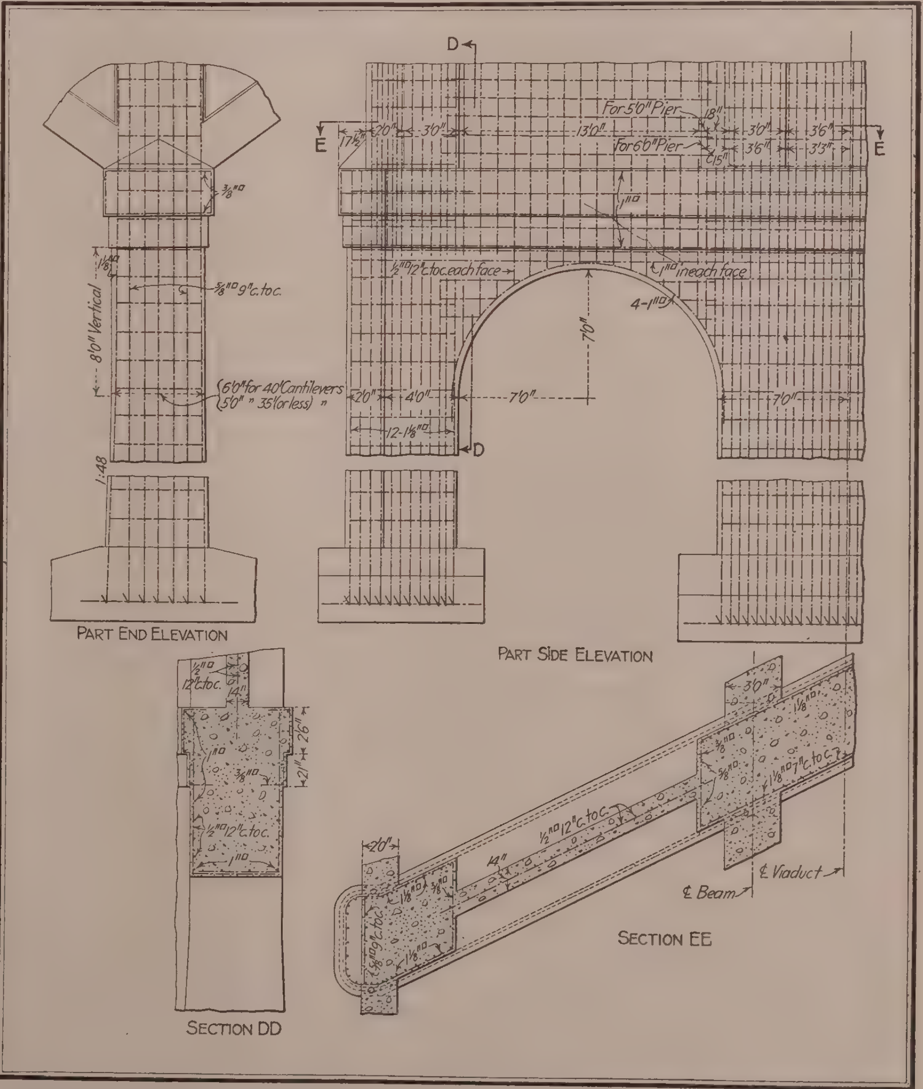
The specifications called for a three-ply waterproofing of alternate layers of burlap and felt, saturated and laid in hot asphalt, to be applied to the top of the concrete roadway slab, and extending continuously from curb to curb underneath the paving and track ballast, and flashing up against the curbs to end in a V-shaped longitudinal groove in the curb at the elevation of the top of the pavement. However, before the paving was laid it was decided to omit the waterproofing, in view of the excellent quality and density of the concrete in the roadway slab, and because experience with wood-block pavement showed that, when laid on a reinforced base, it soon provided an impervious surface under ordinary traffic and did away with the necessity for a waterproofing membrane. About $3000 was saved by this omission.

Between the interior cantilever ribs and directly below the roadway slab a pipe gallery for service pipes and conduits was constructed. Man-hole entrances to this gallery from the roadway occur about every 100 ft. Drainage for the roadway surface is provided by cast-iron gutter inlets about every 350 ft. East of Mill Creek these inlets are connected to the sewer in the street below, but to the west there was no existing sewer, and the drainage is set free at the surface of the ground.

ALLOWABLE UNIT STRESSES

	Pounds per Sq. In.
Tension in reinforcing steel:	
Piers and footings	20,000
Superstructure	18,000
Compression in all concrete—extreme fiber.	700
Shear taken by concrete	65
	Tons
Average dead load on concrete piles	23
Average total load on concrete piles	27
Maximum load on piles, unbalanced live load	35
Maximum footing pressure on—	
Rock	8
Earth	3

The sidewalk railing is of solid panels with a smooth surface, brushed to expose the finely crushed aggregate. Expansion joints occur in the railing over the corresponding joints in the sidewalk, tarred felt and tar paper being used between the surfaces in a manner similar to that described for the roadway joints. The railing was so de-



HEAVY REINFORCEMENT IN PIERS TO INSURE STABILITY UNDER UNBALANCED LIVE LOADING signed that its panels could be poured separately, as units, in a horizontal position, using the same forms many times, and then hoisted into position between the post forms and concreted rigidly into the posts. The contractor did not follow this method, however, but used a set of steel forms and poured posts and panels monolithically in short sections, upright.

The fill approaches at each end are retained between reinforced-concrete cantilever walls. These walls were originally designed with counterforts, but at the request of the contractor were redesigned as T-walls. This design increased the yardage somewhat, but the contractor figured a saving in forms to more than offset this extra concrete and steel. At the railroad tracks a steel staircase permits pedestrians to descend to the Hopple Street station. This was designed of steel with bolted connections in order to facilitate its removal in case the station is moved to another point when the proposed storage yard is built. Two concrete stairways lead down at diagonal corners to Spring Grove Avenue, an important traffic-way. They are supported on double-column bents, independent of the viaduct.

VIEW OF FINISHED HANDRAILING

The plans for the viaduct were completed and the contract let in the fall of 1913. Construction was started in April, 1914. The total cost of the viaduct and approaches, exclusive of land and damages, will be about $450,000. The cost of land and the damages awarded to adjacent property will be close to $100,000, making the total cost of the entire grade-crossing elimination $550,000.

The plans and specifications were prepared in the city engineering department, of which H. M. Waite was then chief engineer; F. L. Raschig, engineer of structures, the writer being in charge of design, and J. R. Biedinger, assistant engineer, working out the details and computations. The construction was supervised by F. S. Krug, chief engineer; F. L. Raschig, principal assistant engineer; Paul Laur, assistant engineer, and P. R. Kirstein, resident engineer. The Kirchner Construction Company is the contractor. For the Baltimore & Ohio Railroad the plans were approved by F. L. Stuart, chief engineer, and the construction was supervised by A. M. Kinsman, engineer of construction, and C. W. Milholland, resident engineer.

Connection Between Subways in Service

The connection between the Grand Central Station, the Interborough subway station and the Queensboro subway in New York City has been placed in service. This makes it possible for passengers to transfer between the two subway lines without going on the street.

Two Breaks in Barge Canal Quickly Repaired

Concrete Power House on New York Canal Fell Ten Feet Without Breaking—May Be Placed on New Superstructure

DURING the early part of July two breaks occurred in the New York Barge Canal which, though serious, delayed navigation only a few days. The first was at Palmyra, the second at Little Falls. Their quick repair is described in the monthly Barge Canal *Bulletin*.

Around the south side of lock 29 at Palmyra there is a bypass channel in which the power plant had been located. Just below the power house a stream comes in from the south and flows along the bypass into the canal prism a short distance farther east. This creek undermined the structure to such an extent that the southeast corner of the power house settled about 10 ft. As a result of this failure the 3-mile level west to Macedon was drained and traffic suspended.

To restore navigation a cofferdam was built across the bypass channel above the site of the power house. The nearby lock was affected only in its loss of power. As this plant supplied power for both the Palmyra and Macedon locks the latter was likewise affected.

CONCRETE PRACTICALLY UNHARMED

Despite the unusual stresses to which it was subjected the power house remained intact, no cracks showing in the concrete, the windows being unbroken and the door in good working order. Much of the substructure also held together. The side walls of the power house had horizontal and vertical reinforcing bars and the roof electrically welded wire cloth. To take the roof thrust, two ties of structural steel were stretched across the house and anchored in the concrete near the cornice line. The roof was covered with tile.

The settlement of the foundation brought into play severe and peculiar stresses, which the concrete withstood remarkably well. An examination showed that such breaks in the concrete as did occur were mainly caused by tension, although some were due to shear. There were practically no failures by compression. The house may be raised and moved aside while a new substructure is being built.

BREAK AT LITTLE FALLS

Just west of Little Falls lock the north bank of the canal and a part of the bottom consist of a heavy rockfill. This embankment is used to fill what was once a river channel. The eastern portion of the level above the lock lies near the Mohawk River and at a considerable elevation above it. The lock has a lift of 40½ ft., and consequently there is that difference between the two channels. They are separated chiefly by rock in its natural state, but at the place mentioned this artificial embankment had to be built. To protect the prism the fill was covered by a course of riprap then by one of lining. Above this a layer of concrete covered the bottom and inside bank slope. To prevent leakage puddle was used where the prism ran through the natural rock.

This level was filled for the first time May 16. Gradually a small leakage appeared, which increased until on July 9 a disturbance of the water in the canal showed where the trouble was. The guard gate was closed and the water drawn, and as the water lowered small leaks in the puddle and seams of the rock were located. When the concrete was uncovered it was found that there had been a marked settlement and that cracks and breaks extended over a considerable area.

Repairs were made by grouting the fill through holes in the concrete, filling the main leak with concrete, placing a layer of concrete over the cracked portion on the slope and grouting the smaller cracks and seams. After repairs had been made to the gratings which had become displaced at the lock culvert entrance the level was filled and navigation resumed with less than five days' interruption.

The cause of the break has been attributed to a settlement of the rockfill into the silt of the old river bottom. There is about 19 ft. of water in the prism at this point, and this added weight, together with the washing away of the finer material in the fill, seems to account for the occurrence.

Drive Roosevelt Drainage Tunnel Rapidly

Monthly Record of 437 Feet Penetration Made in 27 Days of Three Shifts Each in Wet Cripple Creek Bore

A RECORD of 437 ft. penetration was made in August in the Roosevelt drainage tunnel being driven to drain the Cripple Creek mining district. Only twenty-seven days of three shifts of eight men were worked. The best previous record was 400 ft., made in January, 1909. The tunnel is 4 miles long now and 1800 ft. below the surface. Its width is 9 ft., and it is 8 ft. high in the clear. There is a ditch or waterway at one side 4 ft. wide and 2 ft. deep in the center. The material is a hard volcanic breccia, with occasional dikes of basalt and phonolite, also very hard. Usually it requires at least thirty holes to break a round. From 5 to 7 ft. only is broken per round. Little timbering is necessary. The rock is hauled from the face by mules and hoisted out of the Elkton shaft. Water is coming out of every fissure and crevice in the rock, the total flow at the portal now being 10,300 gal. per minute. This makes it necessary for the workmen to wear heavy rubber boots and clothing.

The drills used are the Ingersoll-Leyner Model 18, with 2¼-in. bits for starting. Two drills on a horizontal bar are worked in each shift.

It is intended to drive the tunnel 6400 ft. farther to the Golden Cycle shaft, although it is now rapidly draining the entire district.

The force of skilled tunnelmen doing the work is handled by Charles F. Fuller, superintendent. T. R. Countryman is chief engineer.

Motor Trucks to Value of $90,000,000 Exported Since Outbreak of War

Motor trucks to a value of $90,000,000 have been exported by American manufacturers since the outbreak of the European war, according to figures given by Harry Wilkin Perry, secretary of the commercial vehicle committee of the National Association of Automobile Manufacturers, in the *Literary Digest*. Many of those shipped to Europe, particularly to Great Britain, were for private use in industrial and commercial establishments. The total number of trucks shipped is 32,000.

Waterworks Practice Discussed at New England Association's Convention Last Week

Abstracts of Some of the Papers and Committee Reports Presented at the Annual Meeting, Held in City Hall, Portland, Maine, September 13, 14 and 15

Leakage from Pipe Joints Warrants Investigation

Without Co-operation of Members in Supplying Information Committee's Work Will Prove Futile

By F. A. BARBOUR
Chairman of Committee on Pipe Joint Leakage

ON Sept. 7, 1915—as a result of a paper read by Arthur H. Smith before the New England Waterworks Association—a committee was appointed "to investigate experience in the leakage of pipe joints." This committee consists of C. E. Davis, S. E. Killam, C. M. Saville, H. B. Machen, A. H. Smith, E. G. Bradbury and the writer as chairman. The present statement is not a progress report from the committee; rather it is made for the purpose of inducing a more active interest in the investigation by the members of the association, and particularly with the hope that a discussion may result which will be of value in the further work of the committee.

HOW INFORMATION WAS OBTAINED

As the best method of obtaining the results of experience in joint leakage, a circular containing 37 questions was mailed to 430 members of this association and to 124 members of the American Waterworks Association. From the 554 circulars sent out 131 replies have thus far been received, 46 of these being from the members of the American Waterworks Association. Only 85 replies were received from the 430 circulars sent to the members of the New England Waterworks Association. When only one in five members takes any notice of such a circular it is evident that either the subject of the investigation is of little moment or else the members do not appreciate the value of co-operation if any results of value are to be obtained.

It may be—and in regard to this it is hoped that members will to-day express their opinion—that leakage from pipe joints is not generally an important factor, and that the present type of joints driven and tested, or not tested, as may be the practice, is entirely satisfactory. It also may be, and probably is, true that such leakage from mains as does occur is not general, but is rather located in a few imperfectly made joints, or, in other words, that the average present standard of design and workmanship is good enough. While this may be true, it comprehends the subject chosen for investigation, and thus far little information of definite value in reaching any conclusion has been received by the committee.

One fact, however, stands out: Even in the fully metered systems about 20 per cent of the total water supply is unaccounted for by sale to the consumers. Thus, of the 131 replies received, 10 per cent report the services to be entirely metered and 30 per cent more than 85 per cent metered, and the average water unaccounted for, as estimated in these systems, is 21 per cent. This loss is chargeable to leakage from mains or services, or to failure of the meters to register. It would seem to be worth while to attempt to locate the cause of a 20 per cent loss of the water furnished. If slippage of meters is the explanation, this simply means that consumers are getting more than they are nominally paying for; but if leakage from the mains and services is responsible, the result is an absolute loss of water, which costs money to develop and deliver to the distribution system.

METERS WOULD PREVENT LOSS

The average consumption in the 40 systems in which 85 per cent or more of the services are metered is, as reported, 68 gal. per day per capita. The average estimated unaccounted for water was therefore equivalent to about 14 gal. per day per capita, or a loss of 5000 gal. per year per capita, which, if the cost is estimated at $25 per 1,000,000 gal. of water delivered to the distribution system, is equivalent to a yearly cost per capita of 12½ cents, or approximately the interest on $2. In other words, a town of 10,000 people could afford to expend $20,000 in order to prevent this loss of 14 gal. per day per person.

If, then, in these fully metered systems, which undoubtedly represent the best conditions, only 80 per cent of the water supplied is sold to the consumers, the question arises as to whether this should be accepted as the highest standard of efficiency which can be reasonably attempted. If, in any considerable part, the unaccounted-for water is chargeable to slippage of meters, then it would seem desirable that increased attention should be given to the subject of maintained accuracy and sensitiveness of meters. If meter slippage is not the explanation of the unaccounted-for water, then the loss must be through leakage from the mains or services.

LOSS FROM SERVICES

As to the loss from services, 80 per cent of those replying to the circular estimate this to be small or none. As to the leakage from mains, 99 of the 131 answers received do not attempt to estimate this loss; 18 state it to be very small or none; and 14 estimate it in percentage of the total amount supplied, the average of these few figures being 15 per cent.

From the replies already received, therefore—and these presumably are from those departments best able to answer the several questions, or most interested in the problem—it is evident that while undoubtedly a considerable portion of the water supplied is not sold to the consumer, there is little or no definite knowledge of the actual conditions of the pipe joints. The general impression, as indicated, is that the mains are fairly tight and that the leakage from services is small. It may also be inferred from various notes in the replies received that such leakage as may occur in mains is located at certain isolated joints and is not general.

One phase of the investigation as conceived by the committee was that in reference to the practice of testing pipes when laid. Believing that in the majority of cases local conditions would not permit the trenches to be kept open until the pipes were tested, the question was asked as to the reasonable allowable leakage in testing after backfilling, as determined by the measured water necessarily introduced to maintain the test pressure. Such a method of testing is of course not to be compared with the visual examination of the joints under pressure, but it is necessary in many cases.

TESTING OF PIPE

Of the 131 replies received in reference to testing pipe when laid, 76 state that such tests are made, 36 that no tests are attempted, and 19 that sometimes the pipes are tested and sometimes not. The interesting and rather surprising feature in these replies is that all but six of those who state that the pipe is tested report that the test is made before backfilling the trench. Further, of the 75 who replied to the question as to the standard of tightness required before putting the pipe in service, 63 state this requirement to be "absolute tightness." Of those who report that it is customary to test the pipe when laid, 85 per cent state that the test is made under the working pressure which the pipe is to carry in service. Only 18 report tests in excess of working pressure, the test pressures ranging from 30 lb. excess to double the working pressure.

From the information received to date it therefore appears that it is quite the general practice to test before backfilling and to require absolute tightness under the working pressure. If these replies can be accepted as expressing the general practice of water departments it is evident that the present standard is high, and the only question which might profitably be asked is as to what happens to the joints when the higher pressures due to water ram, and more or less incident to the operation of every system, are applied, and whether therefore pipes should not be tested at some pressure above that of working conditions. It is noticeable that but very few of the statements made in reference to leakage from mains and services are based on any actual tests after the pipes have been in use for any period of time, and the opinions expressed are generally formed from observation of such joints as have from time to time been exposed. Only four definite statements of tests for leakage of pipe after periods of use are reported, and these indicate only a small loss from the joints.

No information has been obtained in reference to the relative leakage from lead wool, leadite and cement joints. Ten per cent of those replying to the circular have had some experience with leadite joints—the majority of those using this material reporting it to be satisfactory. About 10 per cent have had some experience with Universal pipe joints, but these only on the smaller systems. Eight per cent of those replying to the circular have had experience with machine-driven joints, opinions differing as to the value of these joints as compared with hand-driven.

Naturally only those systems where a high percentage of the services are metered can make any accurate estimate of the water not delivered to consumers. Where less than 75 per cent of the services are metered, waste by carelessness inside the premises of consumers is undoubtedly the great factor in determining the amount of water supplied—a condition which clearly stands out in the replies received, by comparing the water furnished per capita with the per cent of metered services. Thus, with due allowance for special industrial demands, the relation between meters and amount supplied is approximately as follows:

Per cent metered	Gallons per day per capita
100	68
75	75
50	90
25	110
0	125

It is therefore evident, as would be expected without the evidence of the present investigation, that, in the conservation of our water supplies, metering of the services is the great factor, and leakage from mains, except in particular instances, is of minor importance. While this is true, however, there remains the fact that in completely metered systems the average unaccounted for water amounts to about 20 per cent of the total quantity of water delivered to the distribution pipes.

More Information Needed

Whether it is economically possible to reduce this loss by a better type of joint, better workmanship, testing at pressures above the normal, cannot be determined by the evidence thus far made available to the committee. The information most needed to reach conclusions is that giving the results of leakage surveys, of actual tests made after the pipes have been in service some years, of experimental work showing the relation between pressure on the joints and leakage, and, particularly, data from those departments where accurate tests have shown leakage in mains to exist. There is no doubt that in many cases there is a large loss from the pipe system, even though in the replies received to date to the circulars of the committee the great majority regard this loss as very small, or refuse to make any estimate.

The object of this brief preliminary consideration of the subject is to ask that members who have not replied to the circular do so at once, and particularly that any member who has at hand the results of definite leakage tests submit such information, which will of course be considered confidential. An expression of the opinion of members on the general question as to whether further investigation of joint leakage is worth while would be of interest.

Emergency Water-Service Gangs Find Weak Spots

Besides Making Speedy Repairs Special Force Keeps Office Advised of Sections in Need of Repair

By GEORGE H. FINNERAN
General Foreman, Water Service, Boston

THE NECESSITY for a water-service emergency gang of high moral, mental and physical standards in these days of high-pressure service and increased number of pipes is evident to all waterworks men. The old causes of trouble—defective material, water ram and frost—have been supplemented by breaking of hydrants by carelessly driven automobiles, the increased number of hydrants projecting above the surface, and other causes attributed to subways, underground wires, pneumatic tubes, deeper buildings and other modern constructions.

The men of the emergency gang should be selected carefully. They must know the locations of the city's pipe lines so thoroughly that they can tell the exact location of any part of the system, its connection with the main pipe, and the location of the controlling gates. Methods of making quick or temporary repairs must also be a part of the knowledge they should have ready for instant application.

Equipment Affects Efficiency of Gang

Proper equipment is the next consideration in securing the maximum efficiency from the emergency men. Heavy wrenches are needed with which to operate large gate valves and lighter ones should be on hand for the smaller valves. Wrenches for corporation and curb cocks, hydrants and air valves should also be carried. Calking tools, hammers, crowbars, picks, shovels, brooms, hand pumps, spoons to remove dirt from gate boxes, and lanterns of different kinds should also be carried. A gasoline or kerosene torch to thaw out gate covers, a force pump, connection pieces, rubber boots, and a gate finder will be found handy accessories. A useful piece of equipment is a powerful jack to help in extricating the heavily loaded wagon or auto from a soft spot in the road. Plans showing the pipe system should also be carried with the emergency outfit and kept up to date.

Speedy transportation is another important factor in giving the best emergency repair service. This requirement is best met by the automobile in the form of a truck. With seats extending lengthwise storage space is available underneath, and a rear entrance can be provided easily.

Boston's Emergency System

The emergency gang as operated in Boston is divided into three 8-hour shifts, each in charge of a leader. The day shift consists of four men, including the leader. Each of the night shifts consists of six men. There is also a man on duty in the office during each of the night shifts and on Sundays and holidays. He takes all messages and notifications and directs the emergency gang to the point of trouble.

Owing to the 8-hour law men cannot be worked more than six days a week. It is therefore necessary for each man to suspend his work one day in seven. This is so arranged that there will be but one man off on each shift each day. This practice of laying the men off one day in seven reduces the number of men available by one the greater part of the week. To offset this, one more man is added to each shift to serve as a substitute during the absence of a regular man on his night off or during his vacation. Some risk is attached to laying off the leader, as he is the most capable man, and the most serious break is likely to occur the night he is off.

Most of the calls could be attended to by one or two men, but it is necessary to have a sufficient number of men on hand at all times. During the day it is always possible to get assistance in handling large gates, but at night it is practically impossible. Therefore, in the event of a break in the lines of large diameter with water flowing at a great velocity through the valves, it is necessary to have at least five men to close the 36-in. gates. Arrangements are made so that in the event of a very difficult shutdown, where several large gates have to be operated against a strong head, other men on duty in the stable and fire room may be called out to assist.

Method of Procedure

When the emergency car is dispatched to answer a call, one man is left behind at headquarters unless the notification makes it plain that a serious job is at hand. The man at the telephone can usually judge the seriousness of the trouble by the number and rapidity of the telephone calls. Where there is a break of large dimensions, the average citizen considers it his duty to inform the water, police or fire department, whichever in his judgment is the proper one, and the result is an avalanche of notifications directed to the water department. As a rule, there is no mistaking real trouble by this sign alone.

The man left behind at emergency headquarters is available in the event of another call coming in after the car has left in response to the first call. Sometimes the gang is sent out on a trivial matter and a few minutes after its departure notice is received of a serious leak. The man at quarters responds with a horse and light wagon and, if possible, controls the situation himself. If it is beyond his ability, he telephones to the office. In the meantime the office man has been getting in touch with the emergency car and has in all probability directed it to the scene of the second leak by telephone. The occupant of a house or store in the vicinity where the car was called is asked to summon one of the men to the telephone. If this is not possible the men are reached through the police.

It is a rule of the emergency service that as soon as practicable after arriving on a job the man in charge of the gang is to telephone the office his whereabouts, and the nature of the trouble, and receive instructions as to his next move. In this way time and travel are saved by moving the car from job to job, rather than have it return to quarters after each one.

Render Aid at Large Fires

It has been customary, during the last few years, to have the emergency gang report at all large fires, the object being to render any aid that it can in connection with the water supply. In the case of a very large fire where the supply is insufficient it may be possible to reinforce it by opening division gates that are usually kept closed to separate high and low pressure systems. If the fire is in the vicinity of the boundary line of the city, gates may be opened admitting the supply from some adjacent town or city.

The well-organized and properly conducted emergency service in a water department of any large city of to-day is a valuable asset. Beyond its efficiency in its own special line, whereby it saves money by minimizing property losses and public inconvenience, it serves as a stimulant to the department of which it is a part to keep its system up to a high standard of efficiency. The emergency gang in the course of its regular work is constantly uncovering weak spots in the system, and thereby aiding in the general work of the water department.

Opinions on Service-Pipe Practice Summarized

William S. Johnson, Chairman, Submits Committee Report Based on 300 Replies from Water Departments

THE committee on service pipes began its investigations by sending to every water department in New England a request for information in regard to the materials and methods used in service-pipe construction, the troubles experienced, and other matters which appeared to be of interest in this connection. Replies were received from over 300 water departments. There were, however, many things which the committee felt should be further explained, and at two meetings a number of superintendents were questioned in regard to the details of their practice and experience. There still remain, however, many points which should be further discussed, and this report, from which the following extracts have been taken, is therefore made as a preliminary report, with a view to getting a general discussion of the matters presented, so that in making the final report the committee may have the benefit of the views of the members.

MATERIALS FOR SERVICE PIPES

The use of plain wrought iron or steel is becoming rare, while nearly one-half of the places sending in reports now use galvanized wrought iron or steel exclusively; in 56 per cent of the places galvanized iron is used either exclusively or in part. In 95 places lead or lead-lined pipes are used, and cement-lined pipes in 48 places. It is noticeable that the use of cement-lined pipe is largely confined to Massachusetts and New Hampshire, 46 of the 48 places using it being in these two states.

Of the new waterworks systems—those constructed within the past 10 years—the following materials have been used for services: Galvanized, 24; plain wrought iron, 1; lead, 2; cement lined, 9.

CHANGES IN MATERIAL USED

The disfavor with which plain iron and steel are regarded is shown by the fact that 22 places have changed from these materials to some other, while only one place has reported as having taken up this material. Galvanized pipe, on the other hand, has lost only 17 while gaining 46. Lead and lead-lined pipes have gained 18 and 16 places respectively and lost 6 and 8. Changes to cement-lined pipes have occurred in 11 places, and changes from cement-lined pipes to some other material have occurred in 27 places.

A comparison of the number of places now using the different materials with the number of places where this material has been abandoned shows that 63 per cent of those formerly using plain iron or steel pipes have changed to some other material. Eight per cent have changed from galvanized iron; 19 per cent from lead or lead lined, and 42 per cent from cement lined.

Of those places where changes have been made from galvanized pipe to some other material, 13 are supplied from surface sources, 1 with ground water, and 3 with filtered water. Of the places changing from lead or lead-lined pipe to some other material, 5 are supplied from surface sources, 13 from ground-water sources, and 4 from filtered sources. Of the places abandoning cement-lined pipes for other material, 18 are supplied with surface water, 7 with ground water, and 1 with filtered water.

REASONS FOR CHANGE OF PIPE

The reasons reported for the changes are varied. The changes from plain and galvanized pipes are almost entirely on account of rust. The changes from lead pipes are largely on account of the possibility of lead poisoning, although in some cases it has been on account of expense or because of the bursting of the pipes under pressure. Lead-lined pipe has been abandoned on account of lead poisoning and trouble from bursting and because of the difficulty in making joints which will not corrode. Of 20 places reporting the abandonment of cement-lined pipes, 8 were on account of trouble at the joints, 6 for convenience, 2 on account of expense, 1 on account of the difficulty in getting good work, 1 because of rust, 1 because the cement broke off, 1 because of outside rust.

A large proportion of the places where the works have been in operation for a sufficient time report trouble with service pipes no matter what the material used, except in the case of cement-lined pipes. With cement-lined pipes, 54 per cent of the places replying report little or no trouble. With galvanized pipe, 36 per cent of the places report little or no trouble, and with lead pipe 10 per cent so report. The trouble with iron and steel pipes, both plain and galvanized, appears to be through the entire length of the pipe. The trouble with lead pipes appears largely at the corporation cock. The trouble with cement-lined pipes is very largely corrosion of the outside of the pipe just inside the cellar walls, with some trouble at the lead gooseneck.

LIFE OF SERVICE PIPES

The data in regard to length of life of a service pipe and the period that elapses before it begins to give trouble are very unsatisfactory. The averages of the figures given in the returns are as follows:

	Years before trouble begins	Life of pipe, years
Plain iron or steel	12	16
Galvanized	15	20
Lead	10	35
Lead lined	10	23
Cement lined	14	28

The main sources of trouble from corrosion are largely inside the pipes, due to the action of the water. In certain soils, however, there is a rapid corrosion of the pipes on the outside, and, in case the inside is protected, as in the case of cement-lined pipes, this is the main source of trouble. Pipes laid in salt marsh or in cinder fill are certain to be acted upon rapidly. Pipes in clay are much more subject to corrosion on the outside than those in sand or gravel. One of the common places where trouble occurs is at the corporation cock, or where a gooseneck is used at the junction of the gooseneck with the service pipe. Some of the troubles at the corporation cock are due to the tuberculation of the main pipe, which tends to cover the corporation cock. This can be overcome in a large measure by inserting the corporation cock well beyond the inside of the main.

PLAIN WROUGHT IRON AND STEEL

The committee believes that there are very few cases where the use of either wrought iron or steel pipes without some protective coating for services is justifiable. They are certain to become filled with rust, and the expense of cleaning or renewing them will much more than offset the extra first cost of construction. Covering the metal with some protective paint seems to increase its life but slightly.

In the compilation of the returns, wrought iron and steel have been grouped together, as it is evident that the words are used interchangeably in many cases. Of those making returns, however, very few have said that steel pipes were used, and a considerable number have called attention to the fact that only genuine wrought iron was used. Others have stated their belief in the superiority of wrought iron over steel, deeming it of sufficient importance to call for special remark.

The relative merit of steel and wrought iron has been a matter of controversy ever since steel pipe has been on the market. The steel pipe has the advantage of greater strength and lower cost, but the advocates of wrought iron claim that the steel corrodes more rapidly, has a much shorter life, and is more difficult to work. The advocates of steel contend that the life of steel is as long as, if not longer than, that of wrought iron. Both sides produce evidence to support their claims, much of which appears to be trustworthy. The claims of both sides, also, are supported by competent experts.

CONDITIONS GOVERN BEHAVIOR OF PIPE

The behavior of pipes under different conditions is so different that the greatest care must be exercised in drawing conclusions. The action of the different waters on both steel and wrought iron is quite different, so that the results obtained in different places cannot be compared. The action of the water on the pipes depends to a considerable extent on the quantity passing through it, and a pipe which contains dead water much of the time will corrode much less rapidly than one which has a continuous flow. For these reasons conclusions based on the appearance of occasional samples are worthless. The character of the metal should also be taken into consideration, as there is wrought-iron pipe, for example, which is of inferior quality and will not resist corrosion as well as genuine wrought iron, and there is undoubtedly much steel pipe sold as wrought iron.

The experience of waterworks superintendents as indicated by the returns and as shown by previous discussions in the meetings of the association is decidedly unfavorable to steel pipe, and while, undoubtedly, many of those who argue in favor of wrought-iron pipes may be unfamiliar with anything else, and believe in it because they were taught to believe in it, there is certainly a large number of reliable men who have had an extended experience with both materials who are firmly convinced that wrought iron is much superior to steel, and there must be some good reason for this belief.

In regard to the working of the steel, there seems to be no doubt that the same tools used for wrought-iron pipes cannot be satisfactorily used for steel pipes, but that with suitable tools the steel pipes can be worked without any difficulty.

The feeling against steel pipes appears to be chiefly confined to New England, for it is undoubtedly a fact that a majority of pipes used in other sections of the country are of steel, and it is apparent that no more trouble is experienced from the use of steel in these places than is experienced from the use of wrought iron in this vicinity.

GALVANIZED PIPE

The action of water on zinc is comparatively slight, and if the pipe—whether of steel or wrought iron—is completely covered with zinc the life of the service will be very materially lengthened. The chief trouble with galvanized pipe is in the joints, where the water gets directly at the iron, and in the imperfect covering of the iron.

As pipes are manufactured, there is a large quantity of scale left on the pipe, especially on the inside. In the galvanizing process this scale is simply covered with zinc. When the scale becomes loose, as it invariably will, the metal of the pipes is exposed in spots directly to the action of the water and corrosion begins, which tends to loosen still further the scale, and soon the pipe is little better than an uncoated pipe. The wrought-iron pipe advocates claim that the greater roughness of the wrought iron insures a greater quantity of zinc, but the extra zinc in this case is obviously not so distributed as to be of any material value.

If the pipe could be freed from scale before galvanizing, leaving a comparatively smooth surface, the effects of galvanizing would be much greater, as there would be little opportunity for the direct action of the water on the iron. One of the steel companies has now perfected a method of removing scale from the pipes which would seem to be of enormous advantage both in decreasing the friction in the pipe and in making it possible to obtain a much more durable coating of zinc when galvanized. This process, which is applicable both to wrought-iron and steel pipes, is likely to result in the production of very much better galvanized pipe.

Galvanized pipe appears to be the cheapest practicable material for services where the class of street surfacing is not such as to make the renewal of the services a matter of great expense. They will give trouble, especially with waters which attack metals readily, but there is no possibility of danger to health in their use.

Whether steel pipe is as durable when galvanized as is wrought iron is a matter which is open to discussion. If the galvanizing is perfect, it would make little difference whether the metal under the zinc resisted corrosion more or less. With the process for removing scale above referred to, it would seem that a long step had been made toward getting a perfect galvanized pipe.

LEAD PIPE

Lead is in many respects the most satisfactory material to use for service pipes. Its pliability and its comparative freedom from corrosive action make it almost ideal from a mechanical standpoint. The cost of lead pipe of sufficient thickness to safely withstand the pressure is more than the cost of many other materials used for services, but in a paved street the greater duration of life probably more than compensates for the extra cost, and in places where the streets are occupied by other pipes and conduits the ease of getting over and under these obstructions with a flexible pipe is a great advantage. The most serious objection to the use of lead pipe for services is the possibility that the water may dissolve enough lead from the pipe to cause lead poisoning.

CAUSE OF TROUBLE

The reason why trouble has resulted in some places and not in others is found in the different character of water supplied in these places. With soft water which contains considerable carbonic acid, the action of water on the lead is very rapid. Waters obtained from reservoirs are not likely to have carbonic acid, and instead of a corrosive action the water tends to form a coating of an insoluble lead compound on the inside of a pipe. With such waters there is no great danger in the use of lead. The danger in such cases lies in the possibility that at some future time the character of the water will change either by the introduction of new sources of supply or by filtration of the old supply.

It seems to be practically impossible to determine definitely in advance what the effect of any water on lead pipe will be, as the laboratory results fail in many cases to show the action which will occur in actual practice. Tests of service pipes in use for a considerable period are the only safe guides.

LEAD-LINED PIPE

Lead-lined pipe as manufactured several years ago gave much trouble from the separation of the lead lining from the iron, leaving the metal exposed to the water. The pipe as manufactured to-day, however, appears to be durable and prevents the corrosion of the iron or steel very effectively. It would seem that the life of such pipe would be limited only by the corrosion of the outside of the pipe. The expense of the lead-lined pipe is much less than that of lead pipe. All of the dangers from the dissolving of lead which have been enumerated in the case of lead pipes apply equally to lead-lined pipes. The health authorities of several of the New England states advise most strongly against the use of lead for service pipes, even where the character of the water now in use is such as to indicate that there would probably be no injurious effects.

CEMENT-LINED PIPES

Cement-lined pipes, if properly constructed, make ideal service pipes as far as the interior of the pipe is concerned. The cement is not acted upon by water and the interior of the pipe will remain smooth for an indefinite time. There are many places where cement-lined pipes have been in use for many years without any trouble, and there are many others where they have given so much trouble that their use has been discontinued. The reason for the troubles which have been experienced are found to be generally the improper lining of the pipes or the use of fittings which did not prevent the water from getting to the metal.

Much information has been secured in regard to the methods of making cement-lined pipes and of joining them so as to prevent corrosion at the joints. This information will be given in the final report of the committee, but need not be given in detail here.

Trouble with cement-lined services occurs most frequently from corrosion on the outside of the pipe, and especially where the pipe enters the cellar. Various methods have been suggested for remedying this. A short piece of the pipe where it passes through the cellar wall may be incased in cement. Another suggestion is that a coupling be placed just outside the wall, so that the corroded piece may be readily removed and replaced. Still another method is to put in a short section of brass pipe where it passes through the wall.

The use of galvanized pipes for lining with cement undoubtedly gives the pipe a much longer life, as the outside is in this way protected from corrosion to a large extent. Painting the outside of the pipe is resorted to in some places with good results.

SIZE OF SERVICE

The standard size for services is ordinarily ¾ in., but in several cases this size has been increased to 1 in. or even to 1¼ in. for the purpose, chiefly, of lengthening the life of the service. Where plain or galvanized steel or wrought-iron pipes are used, the pipes soon fill up with rust, but the service which they render is fairly satisfactory until the pipes become nearly choked, when they must be cleaned. A 1-in. pipe has about twice the area of ¾-in. pipe and will probably last at least twice as long before it will require cleaning. Where meters are not used, there is some objection to the use of large service pipes, as the waste of water from leaks and from carelessness, and especially the use of water through garden hose, is considerably larger with the larger service. Where meters are used, this objection does not apply, and it seems to the committee that much trouble and expense might be saved, where pipes are used which are liable to corrode, if the services should be made of larger size.

GOOSENECKS VS. RIGID CONNECTIONS

Rigid connections with the main and the omission of the goosenecks are used in a large number of places, and in some places such connections are used exclusively. The advantages of the rigid connections are obvious. They make a considerable saving in the first cost, and they are much more readily cleaned. On the other hand, the gooseneck permits the dropping of the service below the main and away from frost, and it is possible to make the service take any direction from the main. The fact that 83 of the towns reporting use rigid connections to a greater or less extent, and that 56 of these report no trouble, and many others "little trouble" or "some trouble," would indicate that the use of rigid connections is thoroughly practicable.

The almost universal opinion among superintendents, especially in New England, is that the water department should lay and maintain all the services from the main to the stop and waste in the cellar whatever portion of the expense may be borne by the department. The cities and towns in which this is not now done are comparatively few, and in these places the superintendents in many cases have expressed the opinion that it would be wise for the department to take charge of the entire service.

Insurance Rates Call for Grading of Cities

Charles W. Sherman Presents Committee Report Dealing with Waterworks Features of Fire Protection

THE following progress report was presented by the committee on grading waterworks for fire protection, consisting of Charles W. Sherman, F. A. McInnes, C. M. Saville, H. V. Macksey and R. J. Thomas.

It is obvious that in any attempt to fix fire insurance rates equitably some scheme of classifying or grading of cities must be adopted, in which all features which affect liability to fires and the facilities for extinguishing them should be taken into account. In the past, methods of grading for insurance purposes seem to have been of a haphazard character, at least in so far as waterworks were concerned, and it has been impossible to obtain any definite information which would enable one to judge in advance what modifications in grading would result from establishing, or from a radical improvement of, a waterworks system. It has therefore been impossible, as a rule, for waterworks engineers or superintendents to indicate what saving in insurance premiums might be expected as the result of any particular improvement in fire protection resulting from improved waterworks.

It is obvious that the formulation or adoption of a system of grading will not of itself adjust insurance rates. These rates are established by local boards or commissions, not all of which base their grading upon the same subdivisions into groups or classes, and of course the rates fixed in various districts are often widely divergent. The adoption of a scientific uniform scheme of grading is nevertheless the first step toward a systematic and scientific scheme of establishing rates, and after the adoption of a standard scheme of grading it would be possible to estimate what improvement in grading would result from any contemplated change in the waterworks system, and thus compute, at least approximately, what saving in insurance rates can be obtained in view of the rates locally in force.

GRADING PROPOSED BY UNDERWRITERS

The first attempt at a scientific schedule for grading cities and towns with reference to fire defense and physical conditions was prepared by the engineers of the National Board of Fire Underwriters in 1915. This was done as a necessary preliminary to the attempt of the actuarial bureau of that board to classify fire losses and from the study of data thus obtained to establish a basis of scientifically fixing insurance rates.

The grading schedule proposed by the national board is based on several years of careful investigation, by their engineering staff, of the fire-protective features of cities throughout the United States. It is based upon a plan of assigning to the various features of fire defense points of deficiency depending upon the extent of variance from standards formulated by a study of conditions in more than five hundred cities, the natural and structural conditions which increase the general hazard of cities, and the lack of laws or of their enforcement for the control of unsatisfactory conditions. The sum of the maximum points of deficiency is 5000, divided in accordance with the relative features considered, as fixed by the engineers of the national board, as follows:

RELATIVE VALUES

		Points	
Water supply:			
Engine stream basis			1,700
Hose stream basis	2,000		
Fire department:			
Engine stream basis			1,450
Hose stream basis	1,150		
Fire alarm		550	
Police		50	
Building laws		200	
Explosives and inflammables		200	
Electricity		150	
Natural and structural conditions		700	
Total		5,000	

The classification based on this schedule is as follows:

Class of city or town	Points of deficiency
1	0 to 500
2	501 to 1,000
3	1,001 to 1,500
4	1,501 to 2,000
5	2,001 to 2,500
6	2,501 to 3,000
7	3,001 to 3,500
8	3,501 to 4,000
9	4,001 to 4,500
10	More than 4,500 points, or without any fire protection

The detailed schedule in its present form is appended to this report as far as it relates to waterworks features. It must be remembered that this schedule is tentative, having been revised several times, and it is subject to further revision as experience may show it to be desirable.

INTEREST IN INSURANCE GRADING

It may be that some question will arise as to the propriety or desirability of the New England Waterworks Association interesting itself in a manner which, on the face of it, has to do only with the grading of cities for insurance purposes. The manner in which waterworks men may utilize schedules for grading has already been suggested. It must not be forgotten, too, that the engineers of the insurance companies are as a rule hydraulic or waterworks engineers who are devoting themselves to advising their employers, the insurance companies, with relation to the efficiency for fire fighting of the waterworks systems, so many of which are in the control of members of this association. To be sure, the insurance engineer studies also the effect of many other features upon fire hazards and fire protection, but almost all of them have to do with the facilities for quickly and advantageously utilizing the protection afforded by our waterworks systems.

It is obviously desirable, therefore, that the engineers grading these systems with a view to their value for fire protection, and the men in control of the waterworks, should agree as to the methods and points by which rating shall be arrived at. Constructive criticism on a standard grading schedule should therefore be obtained, not alone from the engineers engaged in making such rating, but also from the men having to do with the construction, operation and maintenance of our waterworks systems.

With this idea in view the New England Waterworks Association passed a vote in February, 1916, authorizing the appointment of the present committee.

PROGRESS REPORT OF COMMITTEE

This committtee wishes at the outset to call attention to the notably friendly spirit manifested by the National Board of Fire Underwriters, which has welcomed our criticism and has co-operated with us in every way, sending its chief engineer, George W. Booth, and his principal assistant, Clarence Goldsmith, to confer with us in Boston. In short, the national board has shown an open and above-board policy, and a willingness to recognize the New England Waterworks Association, and the assistance which it could afford, that augurs well for a better future understanding between the waterworks and the insurance interests.

PROPOSED SCHEDULE

The committee has given the proposed schedule careful study, and, considering it as a whole, is satisfied that it is a long step in the right direction. In view of its tentative character, criticisms of the detail, and particularly of the number of points of deficiency assigned to various features, are not of controlling significance at the present time. The classification, when effected, will in the nature of things have a direct bearing upon the actual insurance rates, particularly when studied in connection with the data relating to actual losses now being classified and arranged by the actuarial committee of the national board. It is inconceivable that the rates should continue to be assessed in the present illogical and ofttimes unfair manner. The practical and most desirable result fairly to be expected to follow the adoption of the schedule, as was noted above, is the possibility of determining with reasonable accuracy the saving in insurance that will result from a given expenditure for improvements in a waterworks system. In other words, it will be possible in designing a new system or improving an old one to estimate upon probable insurance rates, just as comparative construction costs are now figured.

In the meetings of the committee considerable criticism developed in regard to certain fundamental provisions of the schedule. After full and free discussion with the engineers of the national board we found that many of the questions raised by us were the same as those which they had met and discussed in their earlier study of the problem, and we are now satisfied that the schedule in its present formative stage is a well-considered one.

CHANGES SUGGESTED

Certain modifications have been made at our suggestion, and others are now under consideration. In two respects, however, we have been unable thus far to agree fully with the engineers of the national board or to convince them of the equity, from their point of view as well as of ours, of certain changes which it seems to us should be made. First, no penalty is assigned to too frequent or unduly large fire pipe connections from distribution systems, nor are rules which should obtain in regard to the granting of such connections considered in the schedule. We fully recognize the imperative need of connections of sufficient size for fire defense, but we equally recognize the necessity of adequately safeguarding them. Water in our mains should be used for fire protection just as poisons are used in medical practice—to cure and not to kill the patient.

The second issue is in regard to the right to existence of the so-called 4-in. hydrant. As submitted to us, the grading schedule would penalize this hydrant under all conditions, since none of the 4-in. hydrants can meet the stipulations as to capacity and friction loss. We fully recognize that the 4-in. hydrant has no place in urban conditions, but we are unable to agree that the same is true under all conditions, and we feel that the logical course is to recognize that the small hydrant, like the smaller sizes of pipe, has its proper sphere. The 4-in. hydrant should be severely penalized in city practice; but in districts where the pipes are properly small and where the necessity of anything more than a single comparatively small fire stream is practically nonexistent, it is believed that no deficiency should be charged on account of the use of the 4-in. hydrant.

The vote under which this committee was established instructed it to report whether or not it was desirable for the association to indorse this or any similar schedule. Your committee is fully in accord with the principle of the schedule under consideration, but does not think it wise or desirable to pass any vote of endorsement at the present time, particularly in view of the tentative character of the schedule and the modification which it is likely to undergo before reaching its final form. No action of the association is therefore recommended at the present time. It is believed, however, that members of the association confronted with problems of this nature will be materially assisted by the schedule, even in its preliminary form.

The report is accompanied by an appendix of proposed standard grading schedules.

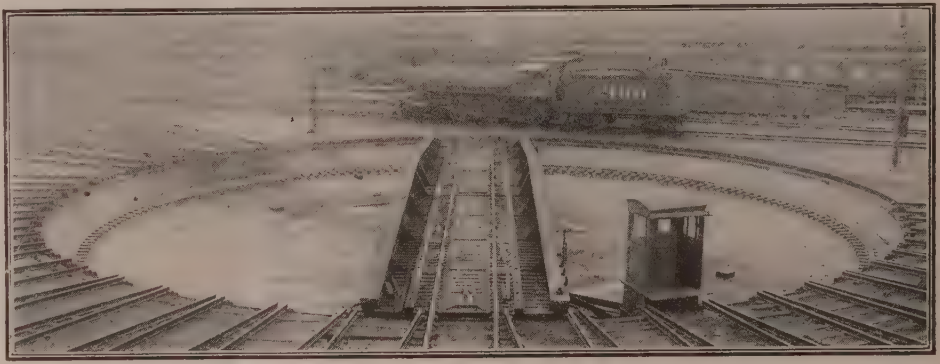
Pounding Prevented in 100-Foot Santa Fé Turntable

Special Cast-Steel Track Blocks and Rail Locks Eliminate Pound in Tables Designed for Heaviest Locomotives

INCREASE in length of turntables required to meet heavy power has emphasized the fact that the pounding at the ends of 75-ft. tables or larger is much more troublesome than for smaller sizes. For tables 75 to 90 ft. in diameter of pit, constructed in the ordinary manner, it costs from $400 to $500 per annum for repairs to the end wheels and center. Turntables having a pit diameter of 100 ft. have recently been designed for the Santa Fé Railway System. As the drop at the ends is more serious than for the 75 and 85-ft. tables, special study was given to the one item of overcoming the pound when engines run on or off.

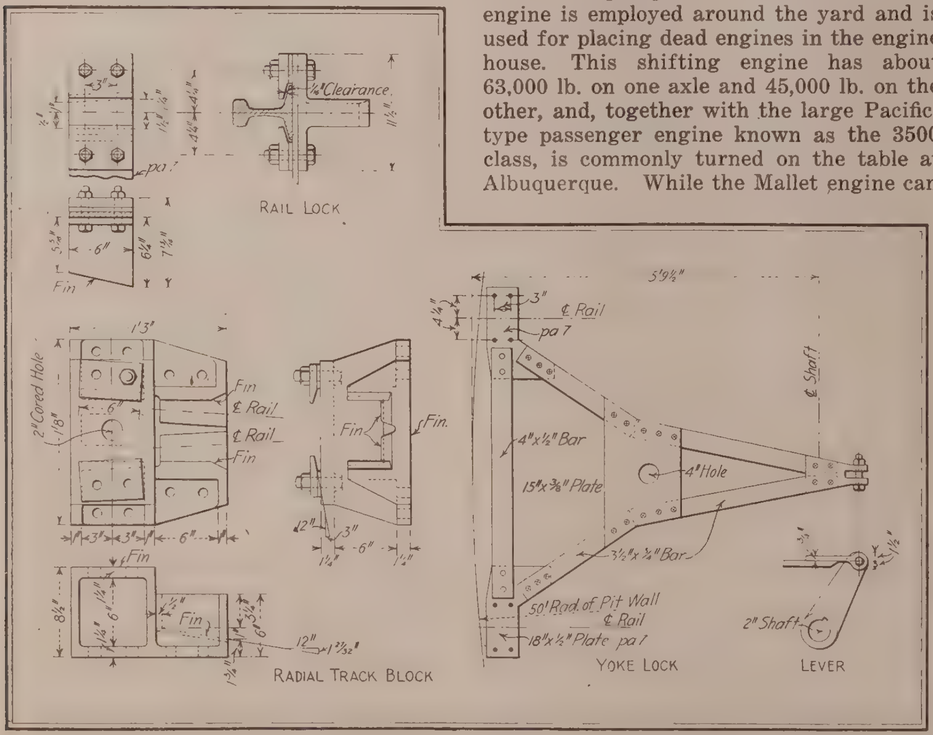
HEAVIEST TYPE OF ENGINE ON TURNTABLE AT WELLINGTON, KANSAS

The 100-ft. turntable is designed especially for handling prairie Mallet engines, which have a length of about 90 ft. between centers of extreme wheels for the engine and tender coupled. The table itself weighs a little more than 90 tons, while the cast-steel radial blocks on the circle walls for forty-six tracks at Albuquerque, N. M., weigh about 19 tons. For the double prairie Mallet engines with tender loaded the distance from center of forward wheel to center of gravity is 46 ft., and with the tender empty this distance is 39 ft.



VIEW SHOWING THROUGH-GIRDER FLOOR SYSTEM AND BRACKET STAYS

At Albuquerque a four-wheel shifting engine is employed around the yard and is used for placing dead engines in the engine house. This shifting engine has about 63,000 lb. on one axle and 45,000 lb. on the other, and, together with the large Pacific-type passenger engine known as the 3500 class, is commonly turned on the table at Albuquerque. While the Mallet engine can be centered approximately on the table when the tender is loaded, the two engines mentioned cannot be centered. This lack of balance has not been found to interfere with the handling of the table, which is operated by an electric motor nominally rated at 20 hp.



DETAILS OF CAST-STEEL TRACK BLOCK AND RAIL LOCKS, SHOWING YOKE

The track rails on the table project nearly to the center of the circle wall, where they meet the radial tracks, which are supported by heavy cast-steel radial blocks. The projecting ends of the rails on the table are also supported on these blocks by the use of shoes which are suspended from the bottom flanges of the track rails. When the end wheels in the table are in contact with the top of the circle track these sliding wedges will just fit tight on the top of the radial blocks on the projecting ends of these rails. By this arrangement the locomotives will run on or off the table without any pounding effect. They are operated by a yoke and lever, the details of which are indicated on the accompanying drawing.

A counterweight is used on the floorbeam at the motor end so that when the table is empty that end is always down on the pit rail. In order to allow engines to run on the high end, an eccentric or cam was used at the motor end; and to prevent breakage of this eccentric a tripping device was used which released the load on the eccentric when the first wheel of the locomotive passed on the table.

This eccentric and the tripping device were applied to the first table only, but were only used a short time. The other tables were ordered without the tilting device or the tripper, and orders have been issued that the motor end of the table is always to be turned to meet the oncoming load. This arrangement does not cause any appreciable delay in handling power and is found to be more satisfactory.

Heavy end trucks with two 30-in. wheels for each corner are used at each end of the main girders. The Santa Fé standard center designed for 500-ton swinging load, similar to the American Bridge Company's type D center, was combined with the through type of plate girders and steel floor.

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

Other articles in this issue of interest to contractors and construction engineers are indexed in the Table of Contents

[*Contributions to this section are solicited, and if found available will be paid for. They must be* SHORT, *and should be accompanied, if possible, by photographs or sketches.*—EDITOR.]

Pump Boat Washes Cofferdam Fill to Place from Barges

By GEORGE W. McALPIN
Junior Engineer, Ohio River Dam No. 35, New Richmond, Ohio

DECK BARGES were loaded with material and towed to position alongside a pump boat, which discharged on to their decks and washed the material into the river to fill a channel scoured at that point to a depth of 28 ft., so that a cofferdam could be built to inclose the remaining parts of the work at government dam No. 35 on the Ohio River. The method proved successful after the ordinary one of scowing in material excavated by dredge had failed to produce satisfactory results. The barges were towed to position alongside the pump boat at a point the right distance above the line of fill to allow the material washed off to settle into place with the current. An old pump boat, equipped with a 12-in. pump and boiler, was used. The discharge from the pump was first directed at material on the downstream end of the barge, and the latter was slowly dropped downstream until all the material had been washed off. The force of the stream from the pump discharge was sufficient to hold the barge away from the pump boat. The stream was directed to the deck of the barge from the ordinary discharge flume, which, as is usual with these boats, was built over the pump discharge across one end of the barge, at a considerable height above the deck.

Three derrick boats were used to load the barges. These carried an average of 150 cu. yd. of material each. The derrick boats each averaged five barges in 8 hours, thus placing about 2300 cu. yd. of fill a shift. The pump boat was, however, able to wash the material from the barges faster than they could be loaded and towed to position, it requiring only 25 minutes to clean off a barge.

The scheme has proved very successful, as the sand and gravel which composed the material were easily moved by water. The same general method has been used in placing banking alongside cofferdams, the material in this case being washed directly against the cofferdam sheeting. The dam is being built for the United States government by the National Contract Company. L. H. Prell, assistant engineer, is in charge for the government.

TEMPLATE SHOWN AT LEFT OUTSIDE COFFERDAM BRACING WAS ASSEMBLED WITH BRACING FOR EACH PIER IN TURN ON WORK TRESTLE

Outside Template Used Repeatedly in Building Steel Cofferdams

By F. P. KEMON
Superintendent, Robert Grace Contracting Company, Harrisburg, Pa.

THE OUTSIDE template shown in the photographs was built by the writer, and used repeatedly in setting up and guiding the new steel sheeting for successive cofferdams required in constructing the piers for the Susquehanna River bridge recently completed by the Robert Grace Contracting Company for the Philadelphia & Reading Railroad at Milton, Pa., and described in the Engineering Record for May 20, 1916, page 676.

The new bridge was built parallel to and directly above the old bridge, and great quantities of large riprap stone, placed to protect the old piers, were encountered in the 8 to 15 ft. of soft material that overlay the rock beneath the river bed. This made it difficult to set the steel sheeting to correct line before driving, and obliged the writer to devise the template shown.

This template was an outside frame of timber 6 in. larger all around than the cofferdam bracing itself. The bracing, assembled with the frame of the template, was built on the work trestle and set in place by a 30-ton locomotive crane. The wales of both the bracing and template were made of doubled 6 x 8-in. oak timbers, with lengths of round wood piling as upright supports and 2 x 10-in. yellow-pine cross-braces.

The template not only made it possible to set up and drive the steel sheeting true to line, but furnished a good foundation for working platforms. After all the sheet piling at one pier had been driven the template frame was removed by the crane and used again at the next pier site. One frame was used successively on all of the 20 x 40-ft. cofferdams. Being set plumb, and driven inside a rigid guide frame, the sheeting itself was little warped, and proved unusually easy to pull.

Winding Cables on Drive Wheel Converts Tractor Into Hoist

By H. S. CARPENTER
Cobleskill, New York

A TRACTION engine was recently converted into a hoist in connection with some of the writer's work by jacking one wheel off the ground and using it as a cable drum. It was necessary to place a 35-hp. locomotive boiler in a location which required that the boiler be transported across a very wet field which would not hold up the traction engine being used to handle the boiler. The latter was mounted on wide skids, but it was not possible to use a single block and a long line to pull it across the soft ground by operating the tractor in the ordinary manner, because there was no room in which to maneuver. Therefore, the engine was anchored down by clipping a wire line to one drive wheel and to the frame so that it could not turn and jacking up the other wheel until it cleared the ground a couple of inches and could be used for a drum. Using for deadmen a couple of stumps near the intended site of the boiler, tackle was rigged up, the lead line wound around the free wheel of the tractor, and the boiler pulled to place in short order.

How Variety of Sheet-Pile Structures Can Be Made Watertight

SIR: In answer to the question appearing in the Engineering Record of Aug. 19, page 242, under the head, "Asks How Variety of Sheet-Pile Structures Can Be Made Tight," the experience of the writer in building two dams of both Lackawanna and Carnegie steel sheeting may be of use. Both dams, built within the last two years, were constructed with single walls of sheeting. Each was about 4800 sq. ft. in area, and each was built in 15 to 25 ft. of water. Excavation inside the dams extended to a depth of 20 ft. over all, and wells were sunk inside them to a depth of 90 ft.

If second-hand sheeting could be driven at all, it was found practically as good as new. There is no advantage in stretching steel sheeting at joints. Watertightness is produced by side pressure of sheet against sheet in the joints caused by the pressure resulting from the head of water outside the dam.

Steel sheeting joints should never be calked. It is better to use a large pumping plant for the initial pumping out in order to get about 1 ft. difference of head as quickly as possible. After pumping is started, men should go around outside the dam with fine cinders, pouring these outside of and against the steel sheeting. The cinders are carried into the joints by the water. The writer has stopped leaks passing as much water as a 1-in. hose with a single shovelful of cinders. After a foot to 18 in. difference in head between the inside and outside of the dam has been established, 75 per cent of the pumping capacity may usually be dispensed with.

The writer used 6 and 8-in. Nye steam pumps, and prefers direct-acting pumps of this type to centrifugal pumps when the latter are mounted on the sheeting, as it has been his experience that the vibration produced by the centrifugal pumps keeps the sheeting in the neighborhood from becoming tight.

Carl O. Johnson,
Assistant Engineer, Department of Public Works.
Chicago, Ill.

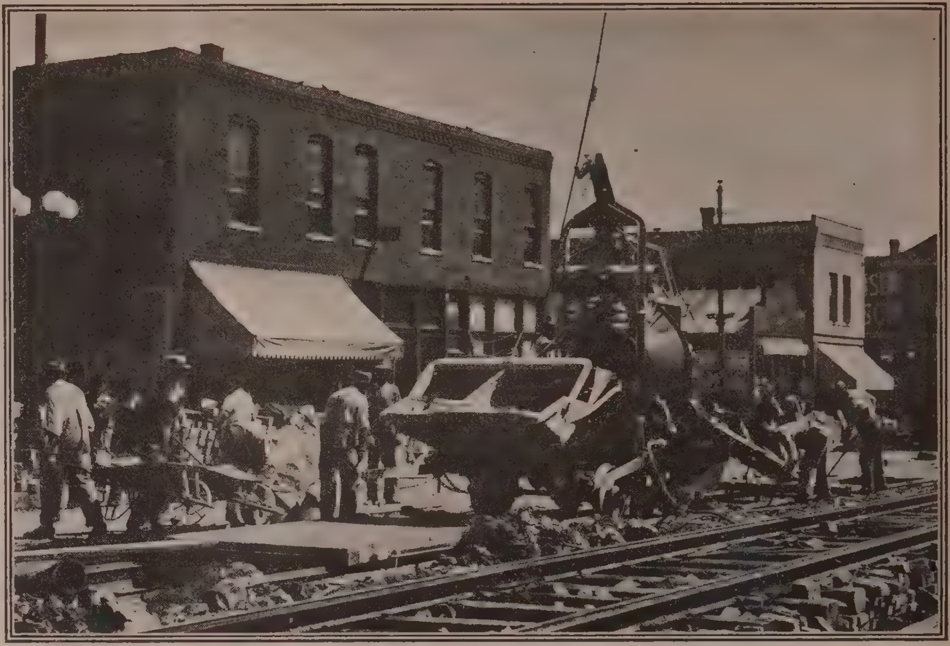
Spar Tree for Logging Topped with Dynamite

In logging by the high-lead system, masts 150 to 200 ft. high are made by using a growing tree from which the small part of the top and the necessary branches are removed. Removing these tops with an axe and saw is likely to prove dangerous, and the Manley-Moore Lumber Company of British Columbia has devised a method of shooting the tops out with dynamite.

After the branches have been removed, a rigger climbs the tree, with a set of irons, to the point where it is necessary to cut off the top. Here the trunk is usually about 12 in. in diameter. The rigger ties a string of dynamite cartridges, fastened end to end like sausages, around the trunk at this point, inserts a blasting cap with about 20 ft. of fuse in one of these sticks, lights the end of the fuse, and is then able to descend to the ground and reach a place of safety before the explosion takes place. The tree top jumps into the air with the explosion, and the trunk is left ready for attaching the rigging for dragging in and loading the logs.

Mixer Mounted on Trucks Paves Street-Railway Tracks

Concrete foundations for pavements between street-railway tracks have been laid on several streets in Kansas City, Mo., during the past summer at the rate of 20 cu. yd. an hour by the ½-yd. Foote mixer shown mounted on wheels in the accompanying photograph. The mixer, mounted on small car wheels, backs away from its work, and is supplied with material from piles along the street. A plank platform for the wheelbarrows to discharge from rests on the rails on the charging side of the mixer, opposite the point where concrete is being poured. It is reached by plank runways, the whole arrangement being moved in a few minutes by four men.



MIXER ON TRUCKS BACKS AWAY FROM WORK BETWEEN STREET-CAR TRACKS

The mixer is in charge of John Denman, foreman for the Kansas City Railways Company.

Hitch Motor to Steam Mixer to Cut Running Cost

An electric motor bought at a cost of $65 and installed on a steam mixer of 10 cu. ft. capacity at a further cost of $6.10 saved this entire cost for Ryberg Brothers of Salt Lake City in reduced operating expenses in the first month of its use. Although electric current enough to operate the 10-cu. ft. mixer at the rate of 60 yd. per 8-hour day costs $1.80, as against $1 a day for coal when using the boiler and steam engine with which the mixer was originally equipped, no special attendant was required for the electric motor, and the wages of the engineer formerly employed to fire the boiler and run the steam engine were saved. At Salt Lake City this amounted to $3.50 per day, making the cost of steam operation per 25-day month $112.50, as compared with $45 for electric operation in the same period.

MOTOR RUNS STEAM MIXER AT SAVING

The low cost of installation is explained by the ingenious manner in which the motor was mounted. The old boiler was, of course, removed, but the vertical engine was not. The motor was belted to its flywheel after the piston rod and eccentric had been disconnected from the crankshaft of the engine. The pulley on the motor is 5½ in. in diameter and the engine has a 24-in. flywheel. The motor is mounted on 8 x 8-in. timbers which extend across the bed frame of the mixer so that an 8-ft. belt center is secured.

Extended Use of Motor Vehicles Brings Increase in Road Construction

A recently completed study of roads in Pennsylvania, New Jersey and New York by the U. S. Department of Agriculture shows that in 1914 roads treated with bituminous preparations made up 15.4 per cent of the improved highways in those states, as against 1 per cent in 1909. Approximately 9 per cent of the improved road mileage of the three states is now surfaced with concrete brick and similar materials, while in 1909 roads of that type constituted only 1 per cent of the improved highways. In 1904 neither bituminous nor the other kinds of roads were found in the three states, and untreated macadam and gravel roads predominated. In 1914 the three states named spent $40,864,831 for road improvement. New York appropriated more than $23,000,000; New Jersey, about $7,000,000; Pennsylvania, $10,000,000. In addition, county, town, and township bonds voted in New York totaled nearly $12,000,000; in New Jersey, $14,000,000; in Pennsylvania, $27,500,000. Altogether the road mileage in the three Middle Atlantic states on Jan. 1, 1915, was 185,770.84, of which the approximate state mileages were: New York, 79,000; New Jersey, 15,000, and Pennsylvania, 91,500. This is exclusive of practically all streets in incorporated cities and towns.

NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

New England Waterworks Men Hear Report

Service Pipes, Leakage, Standardized Meters and Insurance Rates Discussed at Annual Convention in Portland Last Week

Following the traditions of former years, the thirty-fifth annual convention of the New England Waterworks Association, held at City Hall, Portland, Me., Sept. 13, 14 and 15, was notable for the reports of its technical committees. This year's contributions were of a type which made a direct appeal to waterworks superintendents, for they dealt not with the fine-spun theories understandable only by a small group of specialists, but with such homely subjects as leakage from pipe joints, service pipes, standardization of meter specifications and fire-insurance rates—all making a direct appeal to the rank and file of waterworks men. In the technical papers, too, there was reflected a desire to serve the man whose job is to run the water department of his own town rather than design large-scale new work for some other locality. In addition to Superintendents' Day, a familiar feature of former meetings, an innovation this year was the allotment of an entire session to a discussion of waterworks accounting. This move, apparently, was made to impress upon the members the necessity for business methods of cost-keeping and general administration, as well as skill in the handling of the purely engineering features of water-department work.

Program Well Arranged

The program, on the whole, was well arranged and was carried out practically as scheduled—an unusual occurrence at any engineering convention. There was no mass of unfinished business piled up at the close of the final session. The committee had very shrewdly gaged the time available for the technical and business sessions, as well as the entertainment features, and had adjusted the program accordingly, instead of merely listing an impossible number of papers and committee reports according to a devil-take-the-hindmost policy. The only hitch in the schedule, in the opinion of many of the members, was the unfortunate curtailment of discussion following Frank A. Barbour's incisive presentment of water waste through pipe-joint leakage, a subject which, according to the data offered, seemed to be of the most vital importance to waterworks departments throughout the country.

Through the courtesy of the municipal administration Portland's new city hall was placed at the disposal of the association for its convention meetings and the exhibit of waterworks equipment and appliances. While the facilities there were all that could be desired, the site was at some distance from the several hotels at which the delegates stayed.

The secretary's figures indicate an attendance of about 600 members, associate members and guests—figures which rival, if they do not actually surpass, those of last year's convention held in New York City. Of the 600 registered about 200 were active members. Secretary Willard Kent announced the election of 52 additional members at last week's convention.

Report on Service Pipe

After the customary addresses of welcome, a response by President William F. Sullivan, and a short speech by Rear-Admiral Robert E. Peary, discoverer of the North Pole, the convention opened its technical sessions with the report of the committee on materials and methods used in making service connections, presented by William S. Johnson, chairman. This report, reproduced at length on page 387, was based upon replies to questions received from more than 300 water departments. The results showed that the use of plain wrought-iron or steel for service pipe is becoming rare, while nearly one-half of the places covered by the report use galvanized wrought-iron or steel. Lead or lead-lined pipe also has its advocates, and a number of waterworks men believe that cement-lined pipe gives the best results. The committee is of the opinion that there are very few cases where the use of either wrought-iron or steel pipes, without some protective coating, is justifiable. Galvanized pipe, according to the report, appears to be the cheapest practicable material for services where the class of street surfacing is not such as to make the renewal of the services a matter of great expense. Lead pipe was characterized as the most satisfactory material to use, but its cost is high and its use is accompanied by the possibility of lead poisoning. Cement-lined pipes, if properly constructed, are said to make ideal service pipes so far as the interior of the pipe is concerned. Trouble with cement-lined services, the report stated, occur most frequently from exterior corrosion.

Choice of Pipe Governed by Conditions

In the discussion of the report Desmond Fitzgerald, consulting engineer, of Boston, said that with lead service pipe a water is often of a character as to produce a slight incrustation on the interior of the line and thus eliminate the possibility of lead poisoning. Cement-lined pipe, he has found, has given excellent service, but the chief objection to it is that it cannot be bent. W. C. Hawley of Wilkinsburg, Pa., pointed out that no general rule can be adopted for the selection of material for service pipe. This question, he stated, depends upon the chemical character of each individual water supply. In Auburn, N. Y., according to a statement by J. Walter Ackerman, flange connections are employed on all service pipe lines and have been found satisfactory during eight years of use. No leaks have developed, while with wiped joints frequent leaks were detected.

A rather animated discussion of the relative merits of wrought iron and steel for service pipes was participated in by Dr. F. N. Speller, metallurgical engineer of the National Tube Company, and James Aston, representing the A. M. Byers Company, manufacturer of wrought-iron pipe. Dr. Speller pointed out that recent improvements had been made in protecting the exterior of steel pipe by means of bituminous wrapped coatings, which, he said, add about 1 cent per foot per inch of diameter. There is, according to Dr. Speller, little difference between wrought iron and steel insofar as the life of the metal, under waterworks conditions, is concerned. He asked the members who had a preference for wrought-iron pipe to consider whether the evidence available justified them in their selection. Mr. Aston championed wrought-iron pipe, saying that if it did not possess intrinsic merits it would never have gained the popularity which it now enjoys among waterworks men. He described the process of manufacture of this material, explaining how filaments of slag in the metal formed a network of fine lines which resisted corrosion. Robert Spurr Weston, consulting engineer, of Boston, closed the discussion with the statement that the decision in favor of one metal or another must be governed by the character of the water to be handled. Present practice, he said, favors the use of

(*Continued on page* 394)

War Department Approves Drainage Plans

First Stage of Work to Reclaim Lands in St. Johns Valley, Florida, Concluded When Permit to Begin Work Is Granted

Plans for draining about 265,000 acres of land in the St. Johns valley drainage district, on the east coast of Florida, were recently approved by the U. S. War Department. The action ends a long dispute between the department and property owners and marks the first step toward beginning work on the project, which involves an expenditure of about $3,000,000.

250 Miles of Canals

The plans prepared by Isham Randolph, consulting engineer, of Chicago, provide for draining the flood district ino the salt waters of the Indian River. According to present information three main canals are to be projected from the St. Johns River to the Indian River, each to be about 14 miles long, 125 ft. wide and from 14 to 35 ft. deep. The total length of canals and laterals is given as approximately 250 miles. It is said that work will not be started for six or eight months and the job will require about two years for completion.

This information was supplied by C. E. Henderson, city engineer of St. Augustine, Fla.

Dam in Bohemia Fails—300 Bodies Reported Recovered from Flood

The failure of a dam this week near Gablenz, Bohemia, is said to have caused more than 300 deaths and heavy property losses. Several villages are reported inundated and, while no bridges have failed, many are said to be in danger of collapse. The cause of the accident is apparently not known.

The structure that failed is probably one of the old dams built several hundred years ago, as the newer structures are of excellent design and well constructed. The dams in Silesia are in a mountainous district. They are used only to safeguard life and property and to make the streams navigable.

Illinois Central Terminal Problem Discussed at Chicago Conference

Tentative plans to show what is needed in the way of terminal facilities at the Twelfth Street station were discussed at a meeting, held Sept. 20, of the Chicago Railways Terminal Commission and officials of the Illinois Central Railroad. The meeting was a preliminary one and the plans are along general lines only. The conference was for the purpose of enabling the city to draw up an ordinance which will confirm the agreement between the South Park Board and the railroad company, allow the city to go ahead with the work of improving the lake front and permit the railroad company to proceed with the assurance that they will not be held up by the city. A double-deck track system in the layout indicates partial electrification.

Building Collapses in Toledo, Ohio

Many persons narrowly missed death Sept. 13 when a four-story brick building on Summit Street, Toledo, Ohio, collapsed. The walls tumbled into the crowded street without warning. Nobody was killed or seriously hurt. The failure is said to have been caused by removal of supports used while the structure was being remodeled.

Give Dinner in Honor of Alfred Craven on His Seventieth Birthday

On Sept. 16 Alfred Craven, chief engineer of the Public Service Commission, Second District, New York, was 70 years old. One hundred of his friends, both engineering and lay, entertained him at dinner at the Harvard Club, New York City, on the evening of Sept. 15. Many of those present had known Mr. Craven for forty or fifty years, and some of them had been boyhood friends. Jules Breuchaud presided and William Barclay Parsons made a brief address, presenting to the guest of honor a silver tea service.

Springfield (Mass.) Garbage Plant in Bankruptcy

The Springfield (Mass.) Merg Reduction Company has filed a petition in bankruptcy at Boston following unsuccessful efforts to operate the garbage-reduction plant at Springfield without the dissemination of odors. The plant has been shut down since July 1 as the result of an injunction issued on behalf of neighboring residents. The garbage division of the city streets and engineering department has been burying about 50 tons of offal daily in the vicinity of the plant and elsewhere. It is uncertain whether the plant will be taken over by the city, as sanitary experts have severely criticised its location. As garbage, coal and supplies must be hauled 2 miles up hill to reach the plant, a downhill site with railroad connections is favored.

Institute $100,000 Suit Against Staten Island (N. Y.) in Garbage Fight

As the result of opposition to erecting on Staten Island a garbage-disposal plant for New York City, suit has been filed by James E. Gaffney, president of the Metropolitan By-Products Company, against officials of the Borough of Richmond. It is alleged by Mr. Gaffney that his company has lost at least $100,000 by the delay in building the plant caused by what he terms "an unlawful conspiracy" to prevent the location of the works on the island.

National Safety Council Meet in Detroit, Oct. 17-20

The annual meeting and congress of the National Safety Council took place in Detroit, Oct. 17-20. A 40-page program contains the names of 140 speakers. The development of the work has indicated the need for intensive study of the problems of various industries, so that the main feature of the meeting this year was sectional conferences. For instance, the electric light and gas industry members assembled in the public utilities section; the foundry members in the foundry section, and the cement members in the cement section. A new feature of the congress this year was a mammoth safety exhibit, where the latest style types of safety devices were shown.

Amend Reclamation Extension Act

The reclamation extension act of Aug. 13, 1914, was recently amended to allow further time to accept its terms, which permit payments of water charges to be made in twenty instead of ten years. Those who failed to accept the terms of the act of 1914 and still desire to take advantage of its provisions should write to the manager of the project in which their lands are situated for a circular of instructions.

Smoke-Prevention Convention Sept. 26

The eleventh annual convention of the National Smoke Prevention Association will be held Sept. 26 to 29 at the Planters Hotel in St. Louis.

New England Waterworks Men Hear Committee Reports

(*Continued from page* 393)

cement-lined, galvanized or lead pipe for services. Corrosion, Mr. Aston explained, is the result of acid in the raw water and can be corrected by the addition of lime.

Pipe Joint Leakage

Frank A. Barbour, consulting engineer, of Boston, chairman of the association's committee on leakage from pipe joints, presented a statement, which is published in full on page 385, and commented upon in an editorial on page 369. Although the statement contained startling figures as to the amount of municipal water supplies ordinarily unaccounted for, presumably because of pipe leakage, no opportunity for the discussion of this subject was afforded, because the remaining time available at this session had to be devoted to announcements of trips to a local amusement park, a tea for the ladies and lantern slides of pipe breaks. Charles W. Sherman, however, considered Mr. Barbour's statement important enough to warrant publication as a separate pamphlet, to be distributed to every member of the association. He offered a resolution to this effect and it was carried unanimously.

The committee on the Dexter Brackett memorial submitted its final report accompanied by a medal designed by Theodore Spicer-Simson, which is to be awarded yearly for the most meritorious paper presented to the association. For the memorial the committee received in donations the sum of $1,281.50 from 101 contributors. After paying all its expenses the committee had remaining a sum of $197.34, which was turned over to the association. This sum, kept as a fund, will produce an income approximately sufficient to pay the annual cost of the medal, case and engraving.

Standard Meter Specifications

The reading of the committee report on grading waterworks with reference to their value for fire protection (see page 389) was followed by a statement from Robert J. Thomas suggesting that the association appoint a committee to prepare standard specifications for water meters. In this work Mr. Thomas sees a great opportunity for the association to be of service, for the majority of present specifications, he said, contain simply a few broad requirements which all meters can fulfill. Mr. Thomas' remarks led to the passage of a resolution creating a committee to consider and report on the feasibility of a standard specification for water meters and on the advisability of attempting the collection of test and repair records in such a way as to determine the relative durability and continued accuracy of meters.

Of the technical papers several dealt with Portland's water-supply system and with waterworks-administration questions in Maine and neighboring states. Judge Cleaves, chairman of the Public Utilities Commission of Maine, explained the benefits to be derived by a state body with powers to supervise matters affecting public health, such as water-supply and sewerage systems. Breaks in main pipes formed the subject of a paper by S. E. Killam of the Metropolitan Waterworks, Boston, while George H. Finneran, general foreman of the Boston Water Service, discussed emergency trucks and repair gangs. An abstract of this paper appears on page 386.

Another of the technical papers dealt with the application of coagulants intermittently in excess amounts at Springfield, Mass. This contribution was by Elbert E. Lochridge, chief engineer of the Springfield Water Department. Discussions by Morris Knowles and Weston E. Fuller brought out the point that the constant watching of filter plant will disclose methods of better operation and, at the same time, reduce costs.

According to a statement by Edward S. Cole, the American and the New England Waterworks associations will co-operate in producing a standard form for reporting water consumption statistics.

The morning session on Sept. 15 was designated as Water Registrars' Session, and was devoted to papers on accounting by Albert L. Sawyer of Haverhill, Mass., A. W. F. Brown of Fitchburg, Mass., and E. L. Pride, public accountant, of Boston.

The entertainment features of the program included boat and automobile trips to Casco Bay and Sebago Lake and a recital on the great City Hall organ, a gift to Portland from one of her distinguished sons, Cyrus H. K. Curtis, the Philadelphia publisher. A vaudeville show by members of the Portland Water District also was scheduled for the last day of the meeting.

The general arrangements for the convention were in the hands of William S. Johnson, consulting engineer, of Boston, while James W. Graham of Portland acted as secretary to the committee and had charge of many of the local features of the meeting. William F. Woodburn was chairman of the committee on exhibits.

Following its custom of last year, the Engineering Record, during the three days' session, published *The New England Waterworks Daily Record*, a four-page illustrated daily paper of convention news.

Engineering Society Activities

The Philadelphia Association of Members of the American Society of Civil Engineers will hold its annual meeting Oct. 2 at the Philadelphia Engineers' Club. F. Herbert Snow, chief engineer of the Public Service Commission of Pennsylvania, will talk on the administration of the Pennsylvania Public Service Company law.

The Detroit Engineering Society, at its Oct. 6 meeting, will listen to an illustrated lecture by C. W. Hubbel, consulting engineer, on "Sewage Disposal and Contamination of the Detroit River."

The Albany Society of Civil Engineers will hold its first meeting Sept. 26 in Keeler's Maiden Lane Hotel. Henry G. Allen, city engineer of Syracuse and consulting engineer to the state engineer, will deliver an address on engineering and public works of the city of Syracuse.

The Municipal Engineers of the City of New York will hold their next meeting Sept. 27 in the Engineering Societies Building. Charles R. Ward, chief engineer of the topographical bureau of the Borough of Brooklyn, will present a paper entitled "Improvement and Protection of Coney Island Shore and Construction of a Proposed Boardwalk."

The League of Washington Municipalities will hold its annual convention in Everett Oct. 12, 13 and 14. The principal topic to be discussed is city planning. Among the speakers are A. H. Dimock, city engineer of Seattle; R. H. Thomson, former city engineer of Seattle, and now city councilman; Paul P. Whitham, former chief engineer of the Port of Seattle, and Dr. J. S. McBride, Seattle's health inspector.

The Illinois State Association of Highway Commissioners and Town Clerks met Sept. 15 and 16 at Peoria. Prof. F. H. Newell called attention to the facilities offered by the state university in original research in road materials and construction. A. H. Hunter, division engineer, State Highway Department, stated that 95 per cent of the 97,000 miles of highways were earth roads, for which only $40 to $50 per mile was spent. Prof. C. C. Wiley spoke on "Bridge Construction." Resolutions calling for more compensation for commissioners and town clerks, who are often paid less than day laborers, were adopted.

What Engineers and Contractors Are Doing

Oliver W. Connet, whose resignation from the Baltimore Sewerage Commission was noted in a recent issue, has been appointed valuation engineer for the Western Maryland Railway, with office in the Continental Building, Baltimore. Mr. Connet studied engineering at the University of Illinois from 1883 to 1886, following which he joined the engineering department of the Atchison, Topeka & Santa Fé Railway as instrumentman. He had attained the grade of resident engineer at the time of his resignation in 1888 to engage in making surveys on the Mississippi River. Two years later, after a brief experience with the Fort Worth & Rio Grande Railroad, Mr. Connet was made assistant engineer in the sewer department of the city of St. Louis. The following year found him once more on Mississippi River surveys and in 1892 he became assistant engineer on the U. S. Portage Lake and Lake Superior Canals in Michigan. He went to Baltimore the next year to take charge of a topographical survey of that city, which required more than two years for its completion. He took up private practice in 1895, but was made assistant city engineer the following year. During the next ten years he directed about $1,000,000 worth of paving and bridge work, and as division engineer for the Baltimore Sewerage Commission, to which position he was appointed in 1906, he had charge of contracts for the expenditure of nearly $6,000,000.

E. Richard, formerly with the Colorado Fuel & Iron Company, has joined the engineering department of the H. Koppers Company at Pueblo, Col. Mr. Richard was until recently employed on the Panama Canal on the construction of concrete blocks for the Atlantic breakwater.

Edward H. Deets, who has recently been associated with C. J. Maddox in the preparation of a real estate atlas for a portion of Montgomery County, Maryland, is now in charge of some road construction for that county as superintendent and resident engineer.

W. F. B. Rubidge has resigned as resident engineer on the Rosedale section of the Bloor Street viaduct, Toronto, for the Dominion Bridge Company, Limited. He will now represent George F. Hardy, consulting engineer, of New York City, on the construction of the dam and power house for the Abitibi Power and Paper Company, Limited, at Twin Falls on the Abitibi River.

Harold E. Ketchum, who was superintendent for the Hunkin-Conkey Construction Company on the Detroit-Superior bridge, Cleveland, has been made vice-president of the Graff Construction Company of Seattle.

W. V. Banister, superintendent of construction for the Stone & Webster Engineering Corporation, will have charge of erecting the new buildings for the B. F. Goodrich Company at Akron, Ohio.

W. Montgomery Mitchell, who for the past year has been employed by the engineering department of the Packard Motor Company, has joined the engineering department of the city of Flint, Mich., as assistant superintendent of waterworks. After graduation from the University of Michigan in 1911 Mr. Mitchell entered the employ of the engineering department of the Detroit Board of Water Commissioners. He resigned in 1915 to go to the Packard Motor Company.

C. R. Chevalier has resigned as division engineer for the Boston & Maine Railroad to become roadmaster of the Portland (Me.) Terminal Company.

James W. Beardsley, chief engineer of the Porto Rican Irrigation Service since 1910, has resigned. During the last six years he has had charge of building several earth and reinforced-concrete dams, canals, tunnels and other construction work for the irrigation service. He was formerly employed by the J. G. White Engineering Corporation on investigations of irrigation projects, previous to which he was for seven years engaged in engineering work in the Philippine Islands as chief of the bureau of engineering and later as director of public works.

John Albert Holmes has been made resident engineer for the J. G. White Engineering Corporation on the three earth dams to be built for the Southern Power Company near Bridgewater, N. C. Mr. Holmes' experience includes seven years as division engineer on the construction of the Charles River dam at Boston, and several years as resident engineer for the Power Construction Company on the large earth dam at Somerset, Vt. He has also had considerable experience on concrete-foundation work.

John L. Hall, who has represented Purdy & Henderson, civil engineers of Seattle and New York City, during the last seven years as second vice-president in charge of the Pacific Coast territory, has acquired the company's interest in the Seattle branch. He will continue the practice in his own name at the present offices in the Henry Building. Mr. Hall will remain on the board of directors of the company with which he has been associated for the past 20 years.

Charles P. Jaeger has resigned as assistant water commissioner of the city of Cleveland. He has been acting commissioner since March 1.

George B. Dusinberre, of the consulting firm of R. S. Mueller & Company, Cleveland, will Oct. 1 become water commissioner of that city.

F. B. H. Paine, William McClellan and Horace T. Campion have formed the engineering firm of Paine, McClellan & Campion, with offices in New York City and Philadelphia. Previous to opening consulting offices in New York City in 1911 Mr. Paine was general manager of construction for the Ontario Power Company for about six years. That was preceded by long service with the Westinghouse Company, whose laboratories he entered in 1886 as a student. From 1891 to 1893 he was with the Edison General Electric Company, returning to the Westinghouse organization and rising to the position of New England manager before his resignation to go to the Ontario Power Company. Mr. Campion's first four years of engineering work were spent in architectural and engineering offices. In 1893 he entered the electric railway field as draftsman for the People's Traction Company of Philadelphia. Two years later he went to the Union Traction Company of that city and in 1899 was made assistant engineer for the Philadelphia Rapid Transit Company. About four years later he was made assistant engineer for the Reinforced Concrete Construction Company of New York City, having charge of all work near Philadelphia. As a member of the John W. Allison Company from 1905 to 1907 he gained further experience in reinforced-concrete work. Since 1907 he has practised consulting engineering as a member of the Campion-McClellan Company. A biography of Mr. McClellan appeared in these pages of the Sept. 2 issue, at the time of his appointment as director of the Wharton School of Finance.

Henry Welles Durham, engineer of Bergen County, New Jersey, who has been home on a 60-day leave of absence, has returned to the border.

Ray L. Jaeger has resigned as inspector in the U. S. engineer's office at Grand Rapids, Mich., to join the Stone & Webster organization. He is at present employed as draftsman on work for the Mississippi River Power Company at Keokuk, Iowa. Mr. Jaeger was graduated from the University of Iowa in 1915, after which he entered the U. S. engineer's office at Grand Rapids.

R. L. Templin, who has for the last few months been in the bridge office of the Kansas City Terminal Railway, has returned to the University of Illinois to finish a research fellowship in theoretical and applied mechanics.

Y. D. Vesely, a recent graduate of the University of Iowa, is employed as transitman for the first and second districts of the Mississippi River Commission. His headquarters are in Memphis, Tenn.

B. V. Sommerville has been promoted from the position of principal assistant engineer to fill the recently-created position of resident engineer of the Pennsylvania Lines West of Pittsburgh, with office at Detroit. Mr. Sommerville entered the service of the Pennsylvania Railroad after graduation from Lafayette College in 1885. Since then he has risen from rodman to the position he now holds.

S. D. Moses has been made resident engineer for the Southern Railway, with headquarters at Spartanburg, S. C. He succeeds W. G. Wallis, who resigned recently.

The Substructure Company is the name of a new engineering and contracting firm organized by Charles Scott Landers, Reuben Davis and Alan M. Ferebee. The office is at 115 Broadway, New York City.

Obituary Notes

Dr. Enrique Munez, secretary of sanitation for the Republic of Cuba, died Sept. 15 in New York City.

Frank Lemuel Clapp, consulting engineer, of Boston, died recently at Dorchester, Mass. He was born in Boston and was graduated from the Massachusetts Agricultural College in 1896. For five years thereafter he was with the distribution department of the Metropolitan Water Board of Boston, resigning in 1901 to join the engineering department of Waterbury, Conn. After about five years in Waterbury Mr. Clapp went to New York City as assistant to the division engineer in the Board of Water Supply. He was later given charge of the Hudson River crossing of the Catskill aqueduct. He opened consulting offices in 1914 and since March, 1915, had been associated with Fay, Spofford & Thorndike, consulting engineers, of Boston.

Prof. F. D. Sherman, head of the department of graphics at Columbia University since 1904, died Sept. 19 in New York City at the age of 56. Professor Sherman was regarded as one of the leading mathematicians of the United States.

Civil Service Examinations

New York City—Applications for assistant electrical engineer will be received until Sept. 28 at room 1400 Municipal Building. Salary $2,280 to $3,180.

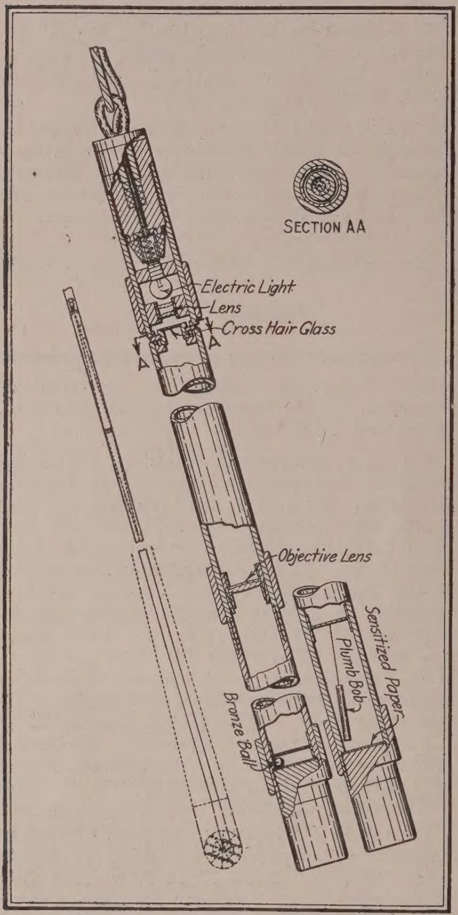
Illinois—Examinations will be held Oct. 7 for junior highway engineer; salary, $75 to $120 a month. Particulars may be obtained from the civil service commission at Springfield.

Examinations Previously Announced

Date		See Eng. Record
Sept. 30.	Assistant engineer and structural engineer, New York	Sept. 16
Oct. 3.	U. S. senior highway bridge engineer	Sept. 16
Oct. 4-5.	U. S. assistant engineer..	Sept. 16
Oct. 4.	U. S. highway bridge engineer, civil engineer, and structural engineer....	Sept. 16
Oct. 11.	U. S. junior civil engineer.	Sept. 16

New Photographic Device Determines Paths of Deep Borings

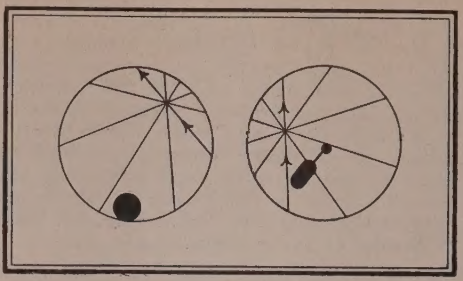
In all deep diamond-drill borings the drill hole deviates considerably from its starting direction, and it is generally desirable to obtain a survey of the hole. The device here shown is the invention of Charles B. Galvin, of Cornwall-on-Hudson, N. Y., formerly assistant engineer on New York City's Catskill aqueduct. Its characteristic features are the formation and recording of an optical line of collimation, tangent to the curving axis of the hole, by the projection on to a disk of sensitized paper of the image of a cross-hair member. The vertical and horizontal directions are established on the photographic print by means of a gravity member—that is, a ball which is free to roll to the lowest point immediately in front of the sensitized paper, or a suspended bob. A diameter is drawn through the print of the center of ball or axis of bob and another at right angles to this, to which the lateral and vertical deviations are referred. The amount and direction of deviation are thereby indicated graphically in the manner of co-ordinates.



SURVEY OUTFIT FOR DRILL HOLES

The function of the instrument, therefore, may be said to be of the nature of a recording transit. A source of light, which may be a 1 or 2-candlepower battery lamp, current for which is supplied from the surface by a cable, is situated in the focus of the condenser in the manner shown. An efficient illumination of the cross-hair glass, which is placed immediately in front of the condenser, is thus obtained, and a well-defined image of the cross-hairs is projected on the disk of sensitized photographic paper at the other end of the tube by means of the objective lens, which is interposed at the proper focal distance between the cross-hairs and the paper. The distance from the cross-hairs to the objective would usually be from 2½ to 4 ft., and from objective to paper from 12 to 30 ft., according to the curvature of the hole.

The cross-hairs consist of lines etched on clear glass, and are so arranged geometrically that their center point can be plotted even though it be off the disk. The pointer, or parallel hairs, are used only to orient the instrument when taking the initial reading in holes that are begun vertically, as all other holes have a known initial azimuth.



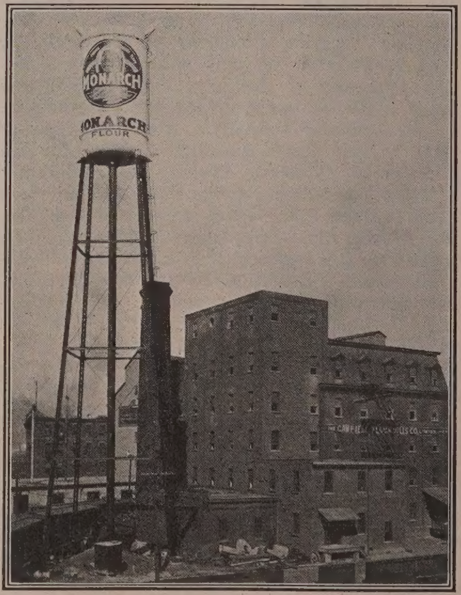
PRINTS FROM DRILL-HOLE APPARATUS—BALL USED AT LEFT AND PLUMB BOB AT RIGHT

A small quantity of flexible collodion applied to the joints when making them up is said to afford an excellent and convenient protection against leakage of water into the hole. Interchangeable collars are fitted over the outside of the tube to provide for holes of different diameters.

It is claimed that the instrument is adapted for use in inclined holes as well as vertical ones, and for holes of small diameter; that it is capable of accurate readings because the methods by which the plottings are derived provide good geometrical leverage; that it is independent of magnetic influences; that it holds its adjustment well and, as a whole, is decidedly rugged; that it is well adapted to being lowered into the hole on a cable, except when there is a great pressure of water in the hole, or in holes that are nearly horizontal, or pointing upward. For such cases the form is modified. The electric battery is then placed within the tube, together with an automatic circuit make-and-break device, which renders the instrument self-contained, and the instrument is then screwed to the drill rods.

Elevated Tank Shaped Like Flour Bag

A unique water tank symbolizing the business of the Campbell Flour Mills Company, Limited, was recently built at Toronto, Ont. The company's flour mills were recently equipped with an automatic sprinkler system to provide fire protection and reduce insurance rates. The tank is used for the storage of water necessary to operate the sprinkler equipment. The prominent position and great height of the structure render it peculiarly effective for advertising purposes, and the company has taken advantage of this fact in having the tank built as a replica of a bag of flour. It is built entirely of steel, painted and lettered to represent exactly the sack in which the company's product is marketed.

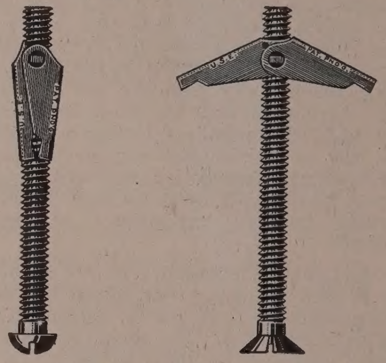


UNIQUE TANK ADVERTISES COMPANY'S BUSINESS

The tank holds 40,000 gal. of water. Its total height is 152 ft. above foundations. The tank itself is 37 ft. deep and 18 ft. wide, being oval in the cross-section to correspond to the shape of a flour sack. The weight supported is more than 200 tons. The work was designed and executed by the Canadian Chicago Bridge & Iron Company, of Bridgeburg, Ont., which makes a specialty of this class of construction.

New Toggle Bolt's Holding Power Equal to Strength of Bolt

A toggle bolt entirely automatic in its operation and said to have a holding power equal to the strength of the bolt itself has been placed on the market by the U. S. Expansion Bolt Company, New York City. A spring inside the toggle head (see illustrations) automatically opens the wings as soon as they pass through the hole. The sharp arrow points grip the inner wall surface, insure instant bearing and prevent turning.



NEW TOGGLE WITH ROUND AND FLAT-HEAD BOLTS. WINGS SHOWN OPEN AND CLOSED

When the bolt threads its way through the trunnion nut and the wings are opened and in place, the inner edges of the wings bear directly on threads of the bolt, providing a positive "lock-nut" effect, which prevents loosening under vibration. The arrow toggles are especially adapted for work in shallow holes, as the toggle wings are only 1 in. long. Arrow toggles, it is claimed, will hold in corners with but a single wing open. Each wing bears individually upon threads of the bolt, which automatically adjusts and equalizes any irregularities on the inner wall surface.

John V. Beekman Is Dead

John V. Beekman, for many years connected with the Lidgerwood Manufacturing Company, died Sept. 11 at his home in Plainfield, N. J. Mr. Beekman was born in 1842 at Somerville, N. J. He later engaged in the manufacture of rotary engines and pumps, following which he became a member of the firm of John A. Lighthall-Beekman & Company, New York City. The company was absorbed by the Lidgerwood Company in 1873, at which time Mr. Beekman took charge of the works. For the last ten years he had not taken an active part in business.

New York Lumber Office Has Good Facilities for Contractors

The Pearson & Ludascher Lumber Company, of Philadelphia, has opened a New York office at 30 Church Street in charge of S. C. Stailey, formerly manager of the Trexler Lumber Company. Mr. Stailey claims that he has exceptionally good facilities for handling contractors' business and points to his company's milling facilities as a good indication of quick service.